Published 1916 as
OIL WEEKLY

DECEMBER, 1955

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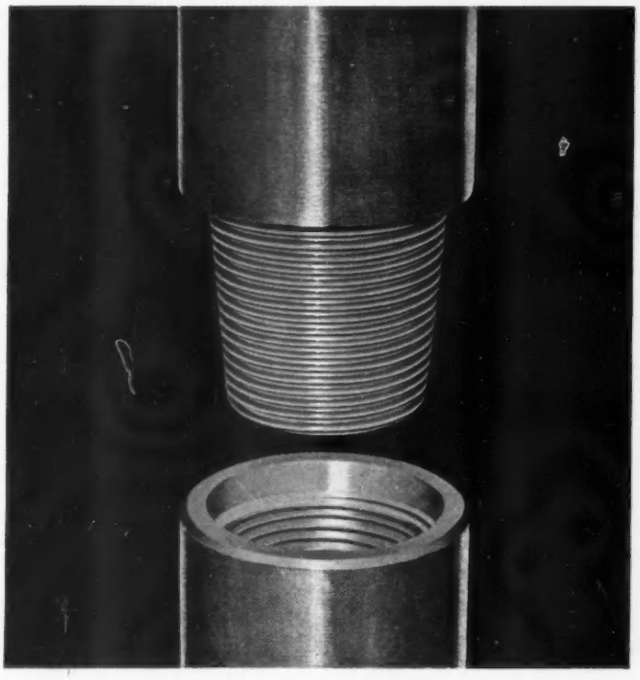

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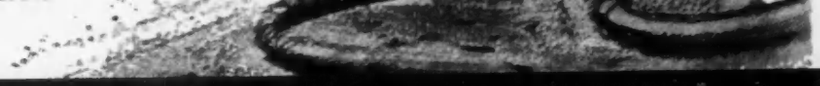

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December, 1955

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Established 1916 as The OIL WEEKLY

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a quick look at WORLD OIL THIS MONTH

BUSY OIL MEN: To help you put first things first, scan these time-saving digests on this and the following pages, checking ☑ those you want to read first.

CURRENT OUTLOOK

☐ **Records are being set** again this year in the Rocky Mountain states. Oil exploration is more extensive than ever before, and more oil production is pouring from the region than in any previous year. Drilling and development expenditures are at the highest levels known. The story of the new record, which begins on **Page 80,** is important, although new peaks have been reached similarly in the region every year

Turn the Page ➧

THIS MONTH . . .

since 1949. The cumulative effect of the steady climb has put development of the region upon a relatively high plane, and the area has assumed an increasingly important role in the petroleum industry of the U. S. Still heading upward, new records are indicated for the future. **New Peaks Are Still Being Reached in Rocky Mountains** ..... **Tom Dougherty**

☐ **Many new oil and gas fields** undoubtedly will be discovered in the 11 states comprising the Rocky Mountain region. This outlook is assured by the favorable geology of the region and continuing wildcatting success. All methods of exploration are being employed advantageously, and as more wells are being drilled, additional data are becoming available. Oil and gas of the region come from many types of traps found in formations of widely varying age, and there are large thicknesses of potential oil and gas formations. For a good over-all view of the geological conditions and possibilities of the 11 Rocky Mountain states, see **Page 84. Geology Assures Many New Rocky Mountain Fields** ..... **Thomas C. Hiestand**

☐ **Important discoveries** in approximately a dozen major geological basins now being developed for oil and gas in the Rocky Mountain region are resulting from extensive exploratory work and drilling. The success, in turn, is encouraging more development, and the region faces a busy future. For reports on the different major basins, revealing what is happening in each and what is planned for the future, turn to the story, **Rocky Mountain Basins Active** ..... **Page 89**

☐ **Mineral royalties** collected by the U. S. government in the Rocky Mountain states constitute one of the important problems of the region. In other states, royalties go to state governments to help finance government costs. To put the Rocky Mountain states on an equal basis, legislation has been introduced in Congress. Under the legislation, royalty monies would be returned to the states to help finance education, highway maintenance, police and fire protection and other state government services. General support of the measure is urged by the Rocky Mountain Oil and Gas Association. See **Page 100. 11 Western States Want 90 Percent Mineral Royalties** ..... **Fred E. Woodring**

☐ **Total demand for all oils,** domestic and export, will be more than 4 percent greater in 1956 than in 1955, it is forecast. This increase in markets, plus a normal addition to stocks, will require a step-up of over 400,000 barrels per day in the new supply of oils. This expansion of supply will have to be divided in a now unknown ratio between domestic producers and importers of foreign oils. The prospective increase in petroleum demand in 1956 will not match the sharp gain in 1955, but it will be about normal and, therefore, favorable. For details on the outlook for 1956 and succeeding years, see **Oil Demand Due to Rise 4.3 Percent During '56. Page 102**

EXPLORATION ARTICLES

☐ **The Blanco-Mesa Verde gas pool** in the San Juan Basin of New Mexico and Colorado, which is rapidly becoming one of the largest in the world, may represent the largest in the Rocky Mountain region. On **Page 115,** WORLD OIL presents an article on the Blanco-Mesa Verde development. The article discusses the field in general, with special reference to drilling and completion practices and characteristics of the producing formation. Read **847,800 Acres: Blanco-Mesa Verde Gas Pool** ..... **R. W. Allen, Jr.**

☐ **The San Juan Basin** is being subjected to a highly technical exploration of subsurface geology and a compilation of engineering data on the fluid systems which control the migration, accumulation and retention of oil. See **Page 120** for the article, **Where Oil Is in NW New Mexico** ..... **Sherman A. Wengerd**

DRILLING ARTICLES

☐ **Bulky equipment,** difficult and inaccessible terrain and freezing weather have teamed up to handicap the Rocky Mountain driller. Through perseverance, initiative and technical advances these handicaps are being overcome. Read how in the article beginning on **Page 135. Rock Mountain Drilling Practices** ..... **C. H. Griffin**

☐ **Lost circulation** in troublesome thief zones is being controlled with increasing success—the secret, the light weight and easy pumpability of plastic foil. The article on **Page 138** describes a number of successful applications of this material. **Plastic Foils "Thief Zones"** ..... **Al Gionta and R. L. Dickson**

☐ **Recent drilling mud practices** for combating lost circulation, sloughing shale, bit balling and water-wetting of pay zones are presented in thumb nail form in the article on **Page 142. Drilling Mud Practices in the Rocky Mountains** ..... **Ray Dillman**

☐ **Air drilling vs. conventional drilling** is presented on **Page 144.** A comparison of drilling rates and time for a conventionally drilled well and two air drilled wells in the Powder River Basin showed astounding superiority of air drilling. Read **3876 Feet with One Bit Using Air** .... **E. A. Polumbus, Jr. and M. S. Legge**

☐ **Diesel oil cement slurry** for squeeze cementing to shut off water has been applied successfully in the field. The article on **Page 153** includes discussions of components of the slurry, factors to be considered on the job and a survey of treatments made last year in various oil producing areas of the country. **Report to the Industry on Diesel Oil Cement** ..... **Charles McLaughlin and Wayne F. Hower**

WORLD OIL, published every month except semi-monthly in February and August. Entered as THE OIL WEEKLY as second class mail matter December 23, 1916, at postoffice at Houston, Texas, under the act of March 3, 1879.

THIS MONTH . . .

☐ **How does size of pipe** and sizes of tool joints, hole and bit nozzle effect the choice of compressor and engines for air drilling. Part 2 of a three-part series, on **Page 156,** describes the effect of well equipment on requirements and results of air and gas drilling. Read **What Every Contractor Should Know About Air Pressure and Volume for Air Drilling . . . James T. Morris and Robert P. Ramsey**

PRODUCTION ARTICLES

☐ **Source, problems and practices** of Rocky Mountain oil production are summarized, basin by basin, beginning on **Page 183.** Geologic data, occurrence of oil, production problems and current production practices of the 11 important basins, with emphasis on a few of the fields in each basin, are presented separately. Maps of the various areas highlight the article. Read **Oil Production in The Rockies. . . . . J. A. Donaldson**

Denver-Julesburg Basin was site of the first production west of Pennsylvania when oil was found in shallow wells at Oil Creek near Canon City, Colorado, in 1862. Today 69 rigs are running and 209 producing fields had been discovered in the basin as of September 1, 1955. Daily oil production is approximately 180,000 barrels. . . . . **Page 183**

Williston Basin and Northern Montana is characterized by a complex stratigraphy, with the most important oil accumulations occurring on the north flank of the Kevin-Sunburst Dome. Production in the Cut Bank field, one of the largest in the area, is from the sandstones within the Kootenai formation and from the upper portion of the Madison group. . . . . **Page 188**

Powder River Basin's Salt Creek and Lance Creek fields, which lie in an area where a number of anticlinal structures are reflected at the surface, produced over 80 percent of the oil from the basin. Noticeable absence of surface indicated anticlinal folds along other segments of the basin perimeter has caused speculation. . . . . **Page 196**

Big Horn Basin contains the largest oil reserves of any major area in the Rocky Mountain region and, at present, is one of the largest producing areas. Current activity in the inter-mountain basin, which began during World War II, is the development of black oil reserves, active deeper testing for black oil in known structures, and use of geophysical methods for search of buried structures. . . . . **Page 201**

Wind River Basin's Dallas field is credited with the first commercial oil well drilled in Wyoming. The field also has produced more oil per acre than any other black oil field in the state. Other fields in the basin have unique production and operational problems, such as burning crude oil in boilers to furnish steam heat for treating oil and for heating houses . . . **Page 208**

Uinta Basin oil has a high paraffin content, 15 to 40 percent with a gravity ranging between 30° and 43° API and a pour point of 90° to 100° F. When problems of high drilling costs, pipe line transportation and high paraffin wax content are solved, activity in the basin should increase substantially. . . . . **Page 212**

Green River and Washakie Basins, separated by the Rock Springs Uplift, have up to 15,000 feet of sediments. Main production in the basins is gas and condensate with two methods of drilling used, conventional rotary drilling with oil emulsion mud and gas drilling. . . . . **Page 224**

Four Corners Area, which includes the San Juan, Paradox and Black Mesa Basins, has experienced an upsurge in activity since first announcement of construction of the Pacific Northwest pipe line, which will be completed this year. Development, before stymied by lack of a market, has gone ahead in 1954-55, especially in the San Juan Basin. . . . . **Page 226**

Laramie Basin lies within Albany and Carbon counties, Wyoming, and Larimer County, Colorado. Main production from the 14 fields, from reservoirs of Cretaceous, Jurassic and Pennsylvanian, has been hampered by water production. . . . . **Page 231**

Hanna Basin development to date has been expensive due to difficult drilling operations. The basin, in Carbon County, Wyoming, is bounded by the Sweetwater Uplift, the north flank of the Sierra Madre Uplift, the Simpson Ridge and Rawlins Uplift. . . . . **Page 237**

☐ **The old adage** of keeping water off the producing formation has been discarded as operators have found that the safety, economy, availability and results of fracturing with water are proving worthwhile. Turn to **Page 238** for a complete discussion. **Fracturing with Water in the San Juan Basin . . . . . J. B. Livingston**

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Turn the Page ➧

INTERNATIONAL ARTICLES

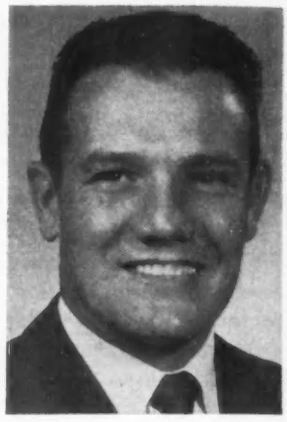
☐ **How do oil field personnel live** in far away places, like Seria oil field in British Borneo? Turn to **Page 255** for a description of daily routine of oil workers now living there. Oil towns the world over have many things in common. One is that tremendous human energy and vast sums of money were required to create them. Seria is no exception. **Tranquil Seria: Southeast Asia's Industrial Center** (A Camp City Profile) .....**Geoffrey Kerr**

☐ **With completion** of Trans-Cuba Oil Company's first deep test in the newly-discovered Tertiary basin south of the Jatibonico field, a thick section of sediments was opened for exploration which brightens the outlook of further efforts. Turn to **Page 260. Cuban Deep Test Proves Up Basin for Exploration**...**Harry Wassall**

☐ **What are the chances** of further oil discoveries in Algeria? Who is conducting exploratory operations there? What indications of oil have been found? For the answers to these and other questions on the current outlook for success in Algeria, turn to **Page 263. Prospects Are Bright for Exploration in Algeria** .....**Maurice Moyal**

John Robertson Is Named World Oil Production Editor

John J. Robertson has been named Production Editor for WORLD OIL. His headquarters will be in Houston. Robertson comes to WORLD OIL from the Houston Division of Welex Jet Services, Incorporated. A 1950 graduate in industrial engineering from the University of Texas, he joined Welex in 1953 and has since participated in perforating, cementing, wire line, permanent type well completion and logging projects in various fields, designing and research capacities. Prior to attending the university, he gained practical field experience in both drilling and production. Robertson has authored several articles which have been published in petroleum trade journals.



John J. Robertson

John N. (Jack) Schuelke, who recently joined WORLD OIL as Production Editor, has assumed the duties of Drilling Editor. W. B. Colvin, former Drilling Editor, has been named Associate Editor, Technical.

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How about passing those practical little ideas or short-cuts along to us so we can tell others about them. If they have helped you, they can help others. Our Drilling and Production Hints are one of the most profitable and popular features of WORLD OIL.

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And beginning with the January issue of WORLD OIL, there'll be some changes in the Hints Section. We think you'll approve. Don't miss WORLD OIL's How-to-Do-It ideas in the January issue.

LETTERS

Argentina Crisis

Sirs:

In your International Outlook Issue of August 15, I read your article concerning a debate caused by a U. S. firm to carry out explorations in Argentina.

The clauses and conditions of this contract, there is no doubt, had a great deal to do with the overthrow of our "Dictator," as in its general form it was inadmissible, and all the defense the Government spokesmen put up in its favor found a solid block in the people, as well as in the various organizations, governmental and private. The privileges were enormous and the obligations had no relation as to the advantages obtained. Just as a simple idea: Giving up 2 percent of the country, including the natural resources as well as oil, for a period of 40 years, on the basis of 13.5 million dollars to carry out an exploration program in four years, with an average investment of 4 million dollars a year, which speaking in oil business terms means "nothing."

The fallen Government did all in its power to hold back the production of the national oil fields, and did not provide the necessary exchange or make use of credit terms offered to purchase oil field equipment from the U. S. A. as its plans included the disintegration of this solid organization in order to deceive the people. But, may I add that with the aid of proper material, the national oil fields are in a position to increase their production 30 to 40 percent within a short period. This naturally will not fulfill all our requirements, but it certainly will help a lot.

Now that freedom reigns again in this country, there is no doubt that with the help of American organizations, technical and financial, we will go ahead with large strides.

I did not want any American friends of mine to think we were not giving them a "fair deal," but this deal was so far from being "fair" that it certainly put a large rock in Peron's way, and again I repeat, it helped greatly to overthrow him. We are, therefore, thankful in a way for this indirect American help towards regaining our freedom.

Ing. Carlos A. Fernandez
25 de Mayo 460
Buenos Aires

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For more information on New Equipment described in this issue, for copies of the literature reviewed, and for data on any advertised products, use the Readers' Service Cards on the last page, just inside the back cover. Circle on the card the editorial or advertising code numbers of the items desired. Sign and mail the card. Your requests will be forwarded to the manufacturer and the information will be mailed directly to you.

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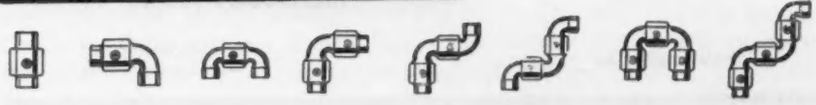

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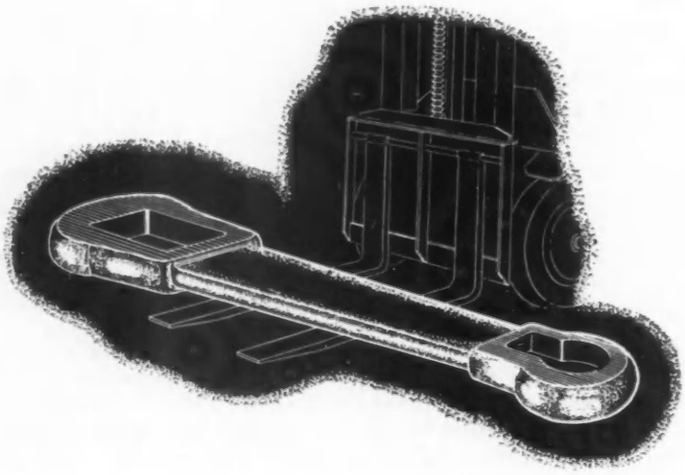

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WHO'S MEETING WHERE

DEC. 1– 3	Interstate Oil Compact Commission, Annual Winter Meeting, LaFonda Hotel, Santa Fe, N.M.
7	Canadian Petroleum Association, Annual General Meeting, Palliser Hotel, Calgary, Alberta.
1956 FEB. 19–23	AIME Annual Meeting, Hotel Statler, New York City.
27–29	AAPG Sixth Annual Rocky Mountain Section Convention, Municipal Auditorium Annex, Denver.
MAR. 7– 9	API, Division of Production, Southern District Meeting, Plaza Hotel, San Antonio, Texas.
18–24	American Congress on Surveying and Mapping—American Society of Photogrammetry, Consecutive Meeting and Co-Exhibit, Shoreham Hotel, Washington, D.C.
21–23	API, Division of Production, Southwestern District Meeting, Texas Hotel, Fort Worth.
APRIL 1– 8	National Oil and Uranium Exposition, Agricultural Association Building, Los Angeles.
3– 5	Annual Corrosion Control Short Course, Extension Study Center, University of Oklahoma, Norman.
4– 6	API, Division of Production, Mid-Continent District Meeting, Broadview Hotel, Wichita, Kans.
14–18	Petroleum Equipment Suppliers Association, Annual Meeting, Boca Raton, Fla.
15–17	Texas Independent Producers and Royalty Owners Association, Statler Hilton Hotel, Dallas.
18–20	National Petroleum Association, Semi-Annual Meeting, Cleveland Hotel, Cleveland.
18–20	API, Division of Production, Rocky Mountain District, Cosmopolitan Hotel, Denver.
22–24	Pennsylvania Gas Association, Pocono Manor, Pocono Manor, Penn.
23–26	AAPG-SEPM Joint Annual Convention, Conrad Hilton Hotel, Chicago.
25–27	API, Division of Production, Eastern District Meeting, Deshler-Hilton Hotel, Columbus, Ohio.
30–May 1	Independent Petroleum Association of America, Semi-Annual Meeting, Statler Hotel, Los Angeles.
30–May 4	API Safety and Fire Protection Meeting, Warwick Hotel, Philadelphia.
MAY 6–15	National Oil and Uranium Exposition, Texas State Fair Grounds, Dallas.
10–11	API, Division of Production, Pacific Coast District, Statler Hotel, Los Angeles.

Nomads' Chapter monthly meeting: Los Angeles, second Wednesday, Jonathan Club, Wallace A. Sawdon, Secretary. Houston, second Monday, Ye Old College Inn, Harry E. Estes, Secretary. Dallas-Fort Worth, first Monday, Greater Dallas Club, M. W. Hiltpold, Secretary. Tulsa, Hotel Tulsa, Gilbert Swift, Secretary. New York, first Monday, Hotel Biltmore, Jesse E. Hickman, Secretary.

Looking Ahead . . .

. . . **Forecasts indicate** that business volume in general may be about 2½ percent smaller at the end of 1956 than at the beginning, due to lower construction, less automobile production, tighter credit and other causes. Even so, the business volume would average about 1 percent greater in 1956 than in 1955. For in 1955 it started out in lower proportions but then steadily expanded until late in the year it was nearly 7 percent greater than at the beginning. Forecasters anticipate a peak in the present boom in early 1956, moderate decline in spring and summer, and a leveling out in the latter half of the year.

•

. . . **The Federal Reserve Board has forecast** that the Gross National Product, or output of goods and services, will reach a new high of $387 billion for the whole year 1955. That would be 7.3 percent above the $360.5 billion of 1954 and 6.2 percent above the record $364.5 billion of 1953. The nation's production was at an annual rate of $367.1 billion in the fourth quarter of 1954 and has risen steadily to annual rates of $375.3 billion in the first quarter of 1955; $384.8 billion in the second quarter; and $391.5 billion in the third quarter; and will approach $400 billion for the final quarter of 1955, up 9 percent over the fourth quarter of 1954. Some economists expect the output of goods and services to hit a peak in early 1956, decline slightly in spring and summer, end the year around $390 billion, and average possibly $392 billion for the whole year.

•

. . . **The anticipated leveling out** of general business volume in 1956 is expected to cause petroleum demand to increase less sharply than it did in 1955. Total demand for all oils in 1956 will be about 4 percent greater than in 1955, it is forecast. This would be a normal growth, though much smaller than that of nearly 8 percent indicated for 1955 over 1954. Some uses of petroleum are relatively independent of general business, including uses for heating and in automobiles. But uses connected with industrial activity and commerce are more sensitive to general business trends.

•

. . . **Business in general is expected to experience a moderate decrease** in earnings in 1956, following the exceptionally profitable operations of 1955. For 1956, profits in all lines in the aggregate may show a decrease of 5 percent or more, it is believed. This decrease would contrast with an increase of about 30 percent in 1955 over 1954. The decline in 1956 would result from higher wages, increased operating costs, depreciation charges on costly new plants, and lower volumes of business in some lines, including possibly construction and automobile manufacturing.

•

. . . **For the petroleum industry,** earnings usually fluctuate less than they do for business in general, due to relatively steady demand for its products. In 1955 oil industry earnings are up less than earnings in general, showing increases around 15 percent. On the other hand, even though earnings in general may be down about 5 percent in 1956, petroleum industry earnings of 1956 possibly may be moderately above those of 1955. For an expected increase of over 4 percent in the volumes of oils marketed might more than cover the extra costs and higher wages of 1956.

•

. . . **That oil industry earnings in the aggregate for 1955** will be 15 percent or more above 1954 is indicated by reported results for the first nine months of this year. Carl H. Pforzheimer & Company, New York, stock brokers, made a tabulation of the earnings of 45 oil companies and found that they reported aggregate net income of $2,148,807,000 for the first nine months of 1955. That was an increase of 15.4 percent over the $1,860,816,000 of profit reported by the 45 companies for the same period last year. Individual company results showed the usual wide differences, depending on the nature and sphere of their operations. Improved earnings have resulted in larger dividend distributions by more than half of the companies in the list.

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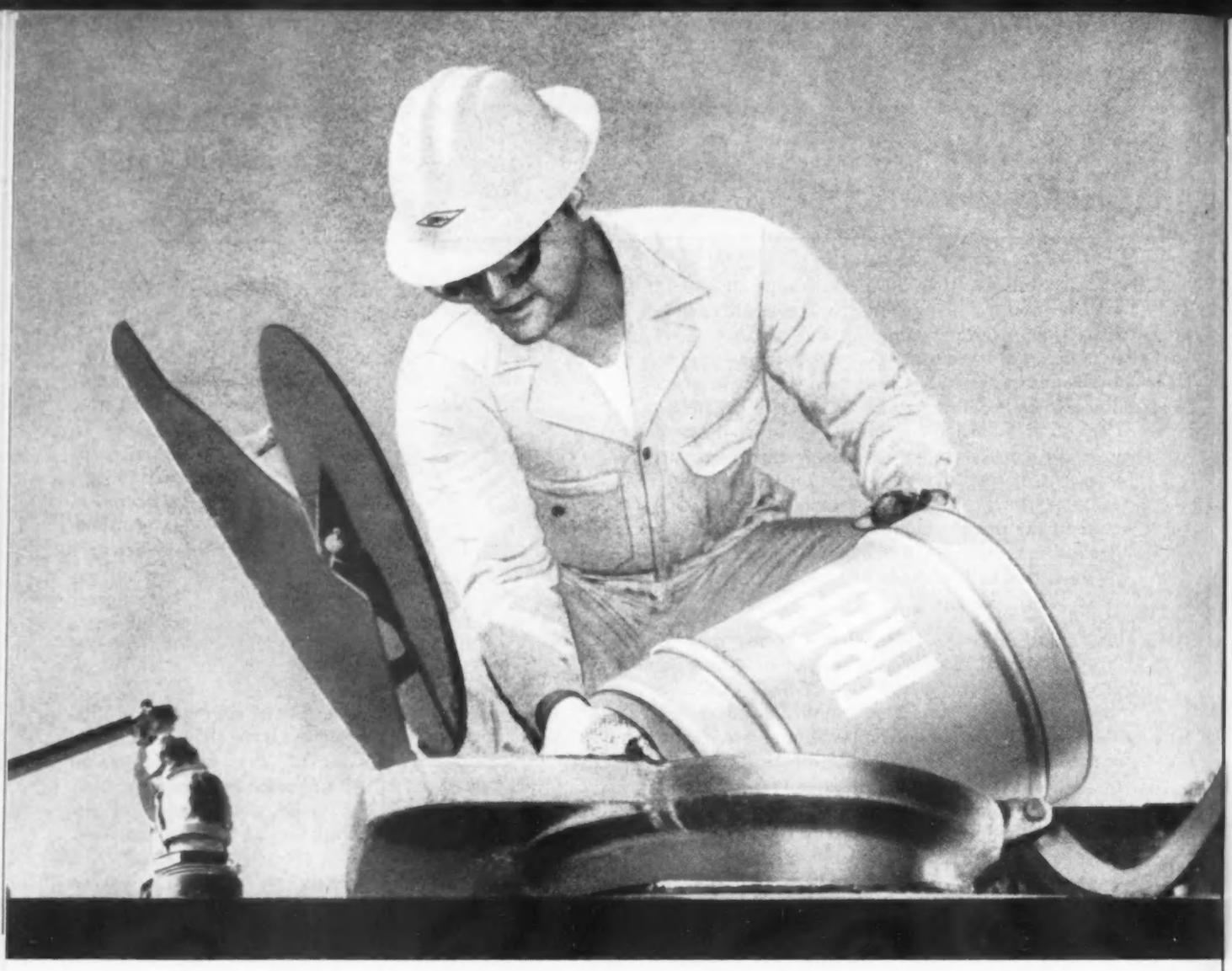
. . . **Inflationary developments** are being viewed with some misgivings by the Federal Reserve Board, which manages the nation's money and thereby tries to maintain economic stability. The board is reported to be worried especially about rising prices of steel, other metals and building materials. It recently found that wholesale prices of industrial commodities had "advanced considerably since mid-year," and that in mid-November they averaged 4 percent higher than a year earlier. The rise in prices has extended in recent months, FRB said, from basic materials to finished goods. Demand for goods and services has been stimulated by swollen credit and increased debt. Heavy buying on credit generates business in large volume but threatens to make demand outrun supply, boost prices excessively, and eventually curtail demand, thus finally ending in a business let-down. In trying to prevent excessive and economically dangerous use of credit, FRB recently made the fourth ¼ percent increase this year in its discount rate—the interest it charges member banks, which in turn raise rates on loans they make.



FREFLO

New DOWELL product breaks water block to open producing formation

Tiny water droplets can kill or cripple oil and gas production when they lodge in the microscopic passages of the formation. Freflo*—another new product developed by Dowell—is helping operators throughout the oil country to break this troublesome water bottleneck.

Freflo is a mixture of several oil-soluble chemical agents. These agents are designed to: reduce the surface tension of the water, lower the interfacial tension between the water and the oil, and break or prevent emulsions. Also, Freflo has proved effective for dissolving asphalt and paraffin deposits.

You'll find Freflo is easy to apply and requires no special well equipment or preparation. Just mix Freflo with diesel oil or fresh, high-gravity crude, then pump the solution into the formation. Or, if you wish, Dowell will do the job for you. One 10-gallon drum of Freflo will make 1000 gallons of treating fluid. The average treatment consists of about 20 gallons of Freflo in 40 to 48 barrels of oil.

Ask for Freflo in 10-gallon steel drums at any of the 165 Dowell offices in the United States and Canada; in Venezuela, contact United Oilwell Service. Or write Dowell Incorporated, Tulsa 1, Oklahoma, Department L-13.

*A Trademark of Dowell Incorporated

services for the oil industry

DOWELL

A SERVICE SUBSIDIARY OF THE DOW CHEMICAL COMPANY

Unfavorable Publicity Points Out Needs

Too much unfavorable publicity continues to plague the oil industry. Several examples appeared in San Francisco newspapers during the American Petroleum Institute annual meeting last month.

One newspaper story stated oil men attending the API resulted in the largest and most expensive collection of privately owned airplanes in the history of California. Another story was about the largest cocktail party ever given in California, costing $27,000. Still another newspaper story said more mink coats than ever assembled at one place were worn by the wives of oil men attending a ladies style show.

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This is the kind of publicity that does irreplaceable damage to the industry. It is such publicity that causes the public to look upon every oil man as rolling in far more money than he needs.

This is the kind of publicity that makes it so difficult for the industry to get a receptive response from the public and members of Congress when it talks about natural gas price regulation, depletion allowance needs, higher prices, and other matters. Such publicity makes it difficult for the industry's public relations efforts to accomplish better results.

It will be a long time before a great many of the general public in California forget these stories. Until this occurs the oil industry will not be held in favorable repute by the public in this area.

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It will do no good for the industry to point a finger at the San Francisco newspapers and accuse them of being unfavorable to the industry. From a strict newspaper viewpoint, these stories made interesting reading for the general public. Therefore, they were good newspaper reporting.

The trouble with these stories is that they failed to present a complete picture. They did not explain that 5400 men—exclusive of perhaps as many as 1800 wives—were participating in the API activities. Nor did they explain that the influx of at least 6000 out-of-town men and women taxed all transportation facilities, that each private plane carried a full passenger load, and that only a relatively small part actually came by privately owned planes.

Nor did the stories explain that several thousands attended the publicized cocktail-buffet dinner party, and the cost per head was not out of line with many previous California parties. Observation would also reveal that the majority of oil wives did not have mink coats. The very large attendance of wives (1780) had much to do with the number of mink coats in evidence.

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The industry needs to come to more fully realize, however, that such publicity does it a great deal of damage.

The publicity in San Francisco newspapers may point out the need for the industry to look more closely at some of its actions, and to guard against things which might tend to create such unfavorable publicity.

Perhaps, more of the industry's planes might have been dispersed at different airports in the area without attracting so much attention. Some thought might be given to the advisability of removing identifying names from the planes.

The number of cocktail parties given at the annual API meeting has increased sharply in recent years. Perhaps, too many large cocktail parties are being given. A number of oil company officials have been heard to express this opinion.

Perhaps, the industry should be careful about holding such a large meeting as the annual API convention outside of Chicago, where it attracts far less attention.

But above all, every one in the oil business should set about to do his share in avoiding actions that might bring such unfavorable publicity to the industry.

Warren L. Baker

New Peaks Are Still Being Reached

Exploration is more extensive than ever before, and more oil production is pouring from the region than in any previous year.

Expenditures for drilling and development are at the highest levels so far known.

This year's expansion is continuation of the steady growth under way since 1949.

Further new records are in prospect for the future, as the region takes on increasing importance in the U. S. petroleum industry.

TOM DOUGHERTY
Petroleum Information
Denver

THE ROCKY MOUNTAIN states are again in 1955 setting new records in oil exploration and development.

Number of wells drilled promises to reach an all-time high. More production has poured from the region this year than in any previous year.

Expenditures are at the highest level yet known in the exploration and development phases of the industry.

But this story is not new. New records are being set in the region each year.

Drilling Expands. The number of wells completed annually in the Rocky Mountain region has increased seven-fold in the past 10 years. In the five years from 1945 to 1950, the drilling volume doubled. In the five years from 1950 to 1955, annual well completions will almost quadruple. In 1945, wells completed in the Rockies totaled 649. The number of completions reached 1213 in 1950, jumped to 3504 in 1954, and will total about 4500 in 1955, it is estimated. (See Chart and Table 1.)

Where will the region go from the 1955 record?

Each year it has been said that the

TABLE 1—Total Wells Completed in Rocky Mountain States.

STATE	1945	1950	1954	*1955
Arizona	3	7	10	5
Colorado	53	87	1,324	1,550
Idaho	...	5	.....	4
Montana	354	268	349	390
Nebraska	7	107	469	865
Nevada	...	2	12	7
N.W. New Mexico	25	109	383	519
North Dakota	7	3	296	260
South Dakota	3	7	20	12
Utah	4	24	69	116
Wyoming	193	594	572	735
Total	649	1,213	3,504	4,463

* Last 3 months estimated.

TABLE 2
Estimated Proved Crude Oil Reserves in Rocky Mountain States at Beginning of Year.
Source: American Petroleum Institute except Arizona, Nevada, Northwest New Mexico, and South Dakota estimated.
(THOUSANDS OF BARRELS)

STATE	Jan. 1, 1945	Jan. 1, 1950	Jan. 1, 1954	Jan. 1, 1955
Arizona	.....	.....	.....	50
Colorado	88,823	344,812	319,254	328,651
Idaho	.....	.....	.....	.....
Montana	111,650	112,393	208,985	272,394
Nebraska	581	1,624	25,621	38,031
Nevada	.....	.....	.....	500
N. W. New Mexico	3,310	4,550	8,000	10,500
North Dakota	.....	.....	128,271	134,349
South Dakota	.....	.....	100	350
Utah	25	12,280	37,937	36,414
Wyoming	581,730	691,602	1,279,110	1,303,577
Total	786,119	1,167,261	2,007,278	2,124,816

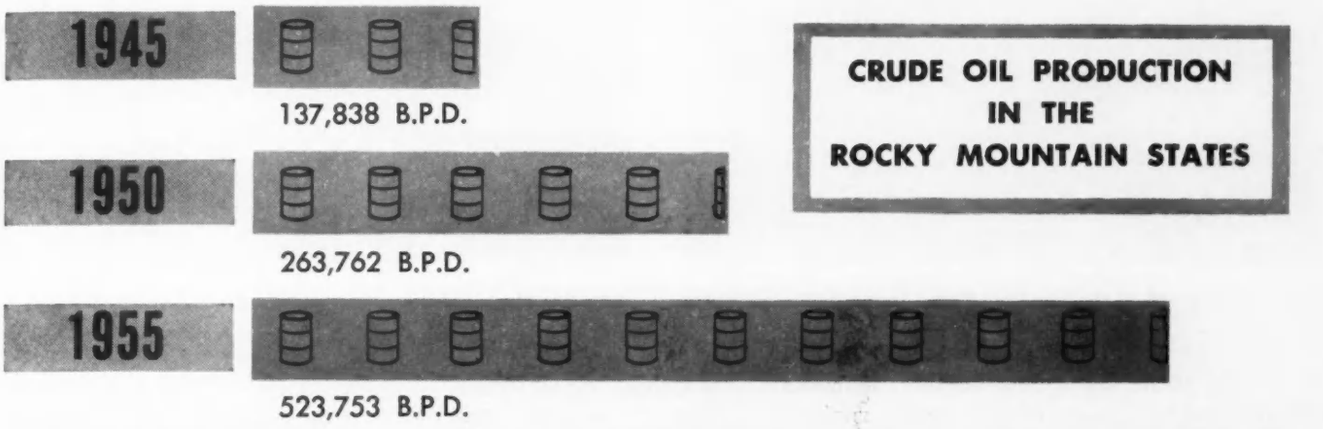
TABLE 3—Daily Average Crude Oil Production in Rocky Mountain States.
Source: U. S. Bureau of Mines, except latter part of 1955 estimated.
(BARRELS DAILY)

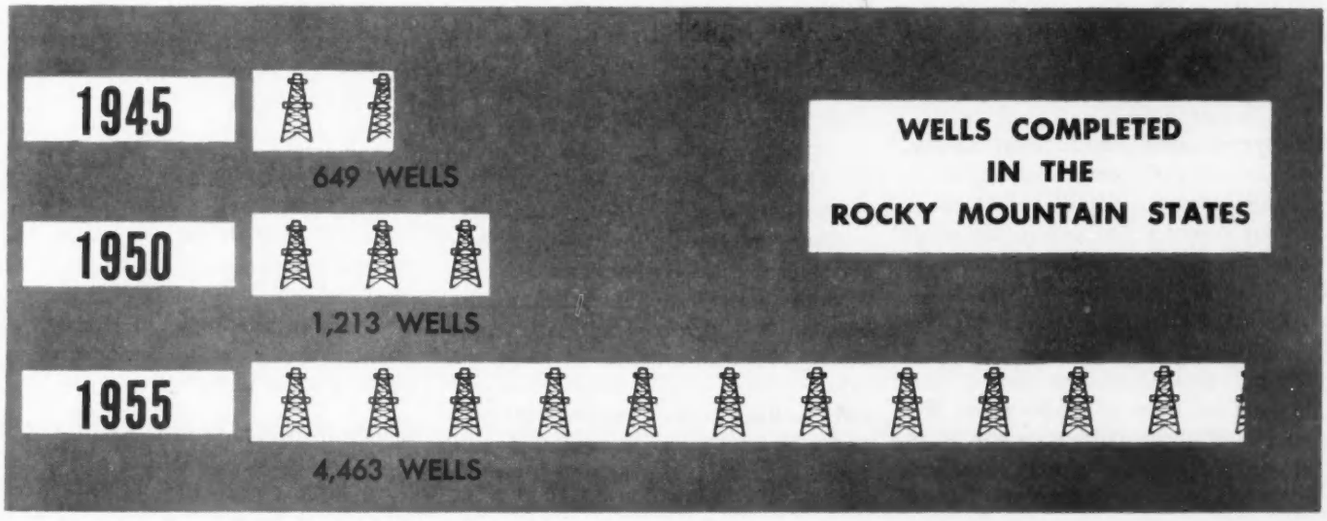
STATE	1945	1950	1954	*1955
Arizona	.....	.....	.....	†
Colorado	13,797	63,844	112,471	139,088
Idaho	.....	.....	.....	.....
Montana	23,068	22,217	37,499	42,989
Nebraska	836	4,238	20,337	26,063
Nevada	.....	.....	90	164
N.W. New Mexico	907	1,247	2,170	2,877
North Dakota	.....	.....	.....	30,939
South Dakota	.....	.....	93	98
Utah	.....	3,364	5,130	5,962
Wyoming	99,230	168,852	256,529	275,573
Total	137,838	263,762	434,319	523,753

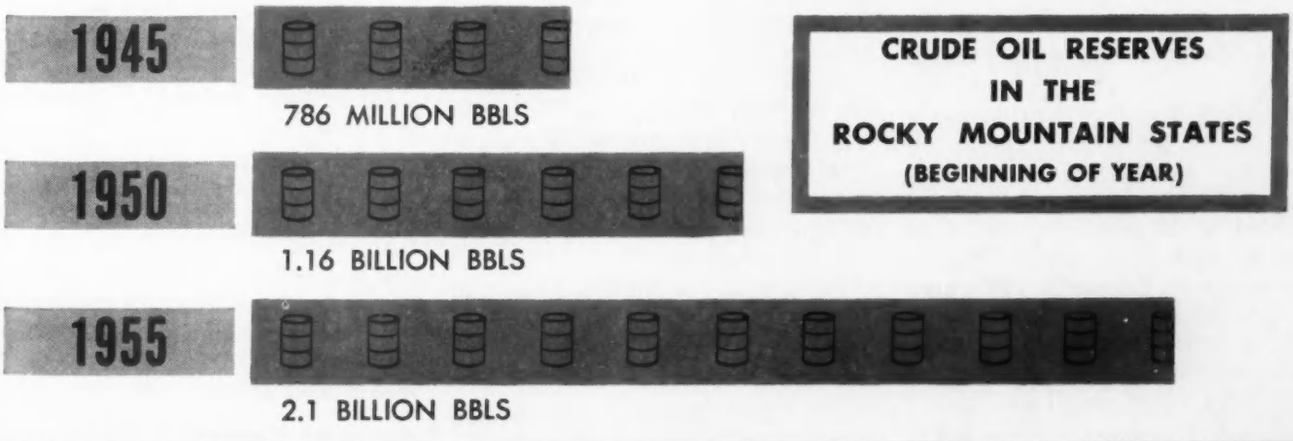
* Last 3 months estimated.
† One well recently yielded oil and gas and then was shut in.

in Rocky Mountains

Operators find 27.53 barrels per drilled foot compared with national average for 1954 of 14.94 barrels per foot.







Gas producing well in the San Juan Basin. Terrain is typical of the region.

Flowing well in Adena field, largest in Colorado part of Denver-Julesburg Basin.

next year would set a new activity record, "barring major industry dislocation." This sort of prediction appears as reasonable for 1956 as it did for 1955 and 1954 and in the preceding years.

Reserves and Production Grow. Production and reserves underlie any drilling growth. Steady addition of proved reserves has constantly characterized the Rockies. The figures for 1954 are adequate illustration.

About 280 million barrels of reserves were proved by the one year's drilling. This was done with a total of 3504 wells completed—about 6¾ percent of total drilling in the U. S. This 6¾ percent of the country's drilling proved approximately 10 percent of the nation's new reserves for 1954.

Proved reserves of crude oil in the Rocky Mountain region have almost tripled within the past 10 years, with the sharpest increases occurring in the more recent years. The reserves increased by one half in the five years from 1945 to 1950, and then almost doubled in the past five years, from 1950 to 1955. They totaled 786 million barrels on January 1, 1945; grew to 1,167,261,000 barrels at the beginning of 1950; and jumped to about 2,124,816,000 barrels as of January 1, 1955. (See Chart and Table 2.)

Crude oil production in the Rocky Mountain states has almost quadrupled in the past 10 years. It doubled in the five years from 1945 to 1950, and again doubled in the past five years, from 1950 to 1955. Output averaged 137,838 barrels daily in 1945, jumped to 263,762 barrels per day in 1950, and will average approximately 523,753 barrels daily in 1955. (See Chart and Table 3.)

These are more basic figures than simple totals of wells completed . . . of footage drilled. They contain the economics of the growth of the entire Rocky Mountain region.

Oil Finding Costs Reasonable. Further, other figures from this region round out the favorable picture. In the major producing states, cost per barrel of oil found compares favorably with the nation as a whole. Wyoming's estimated per barrel cost of new oil found in 1954 was 74 cents. Colorado's cost was 97 cents per barrel. In North Dakota, cost was $1.05 per barrel. In less developed areas, costs skyrocketed, but the more active states had the greatest amount of new oil found, properly weighted the regionwide cost.

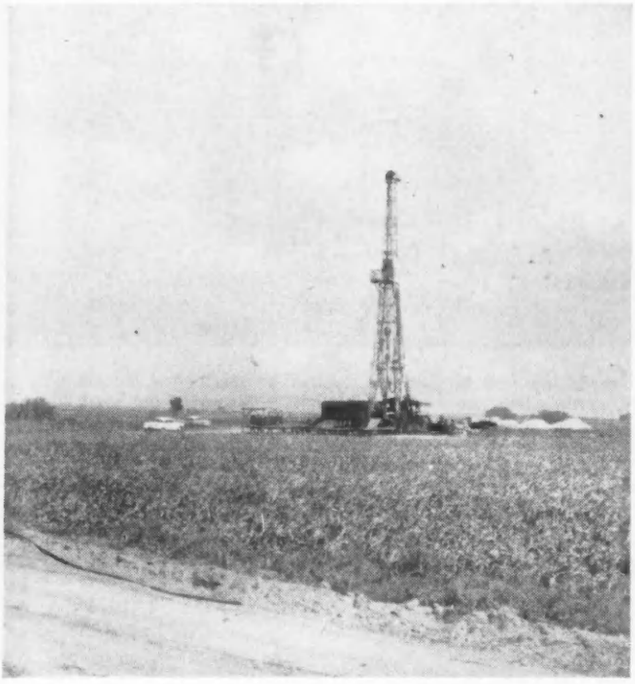
On a barrel of oil found per foot of hole drilled basis, the record for the Rockies is nearly twice as good as the national average. The operators of the region found 27.53 barrels per foot compared with a national average for 1954 of 14.94 barrels per foot. Wyoming led in this direct calculation of returns from drilling. The state had 60.7 barrels of oil added to reserves for each foot of hole drilled. It was followed by North Dakota with 49.3 barrels per foot.

This sort of performance, coupled with the fact that at the end of last year the Rockies had less than 8½ percent of national proved reserves, plus the relatively unexplored status of much of the region, explains the attraction of new operators, and increasing activity.

Crude Markets Good. Another economic basis for increasing activity in the Rockies is the time of capital return factor, now more favorable than ever before. This means simply market outlet and availability of market to the man who has crude oil to sell. Crude markets have been good. A small amount of below-posting crude movement has not hurt the far larger well-regulated marketing performance. Outlet for crude from the eastern side of the Rockies is more plentiful than ever before.

A company or individual can explore almost anywhere in the region today with reasonable assurance that oil, if found, can find a market in a reasonable time.

Adequate Capital. As the industry



Drilling well near Sterling Colorado, in Denver-Julesburg Basin. Typical rig used.

Producing wells in Cole Creek field, about 25 miles northeast of Casper, Wyoming.

in the region has continued to grow, new outside capital, local capital, and capital generated by production has become more and more plentiful. Add to this corollary capital at work in the region, as in uranium exploration and mining, which finds its way from time to time into oil activities, and the total capital situation of the Rockies was never before so good.

Explorationwise, the Rockies region has been characterized by the opening of enough new areas of much promise in any one year to sustain a major program in the ensuing year. 1955 has not been an exception.

Williston Basin. In the first three quarters of the year, discoveries were made east of the Nesson anticline in the Williston Basin, at least one of them of apparently very good caliber. This is potentially the key which may unlock the activity potential of hundreds of thousands of acres of Williston Basin acreage in North Dakota.

After spirited drilling campaigns in 1951, 1952 and 1953, activity toward the east side of the basin declined in 1954 . . . for lack of success. The picture may well have been changed.

Denver Basin. The southeastern corner of Wyoming . . . part of the Denver-Julesburg Basin . . . had two discoveries this year. Additional drilling already has resulted, but this area has a long way to go before it is anything like as well in hand as the Colorado and Nebraska portions of the basin.

A new pre-Cretaceous discovery was made in the Colorado portion of the Denver Julesburg area. Success continued to the south and west, and at least one substantial field was added in Colorado this year.

In Nebraska the greatest local increase in activity of any area in the region took place this year. Exploration pushed limits of production to the west in Kimball County; to the north in Banner and Morrill counties. At the end of autumn, a discovery was made 100 miles east of production in Hitchcock County. At the same time a new exploratory campaign was started on the Chadron Arch.

The Las Animas Arch at the southern end of the Denver-Julesburg Basin in Colorado had a small 1955 discovery. New activity is promised there.

Western Areas. On the west side of the Rockies the construction of the Pacific Northwest pipe line offers a new gas outlet, and has spurred exploration in the Paradox Basin and along the eastern side of Utah, through western Colorado and southwestern Wyoming. Successes have resulted already, with these areas appearing to be among the most promising in the region for new activity.

Success Ratio High. The concentrated activity of the Denver-Julesburg Basin . . . with 41 percent of the region's drilling last year . . . the widespread exploration in Utah, western Colorado, southwestern Wyoming, central Montana and the Williston Basin all considered, the wildcatting success ratio in the Rockies still remains high . . . nearly 12 percent.

The sheer expanse of area still remaining for exploration has helped. Another, and potent factor has been realignment of geologic thinking. Many of today's producing fields are located where the geology of a few years ago said they could not be.

This is a process which apparently will continue if the experience of the past few years is any guide. The promising, yet perplexing variety and complexity of Rocky Mountain geology offers a challenge seldom met elsewhere, and has richly rewarded the geological non-conformist.

More Expansion. Thus, neither in economics nor in geology is there yet in sight a leveling-off point for the Rocky Mountain region. Its attraction, greatly exploited in the past 10 years, still seemingly is as strong as ever.

It is no surprise that 265 rigs were running in the region at the end of June . . . 315 in August and nearly 300 still running at end of October.

But it will be a surprise if 1956 is not again a new record year for the region. —**The End**

Above is typical pumping well in Adena field, Morgan County, Colorado, in Denver-Julesburg. Basin production is obtained at depths of 5000 to 7000 feet. Gravity of crude ranges from 37 to 42 API. Next photo is producing well in Ashley field, Uintah County, northeastern corner of Utah. Third view is one of the numerous gas-producing wells in San Juan Basin, in terrain typical of the region. Fourth view is producing wells in Glenrock field, some 25 miles east of Casper, Wyoming, in Powder River Basin's south end. The last view is of typical

Geology Assures Many New Rocky

By THOMAS C. HIESTAND,
Denver

OPERATORS in the U. S. Rockies are looking forward and sketching plans with broad strokes for tomorrow. Annual increases in production have been the rule for more than a decade, and initial discoveries of oil and gas in such states as South Dakota, Arizona, and Nevada show the vigor and momentum of activities headed into tomorrow throughout the territory covered by Figure 1, as shown on Page 88.

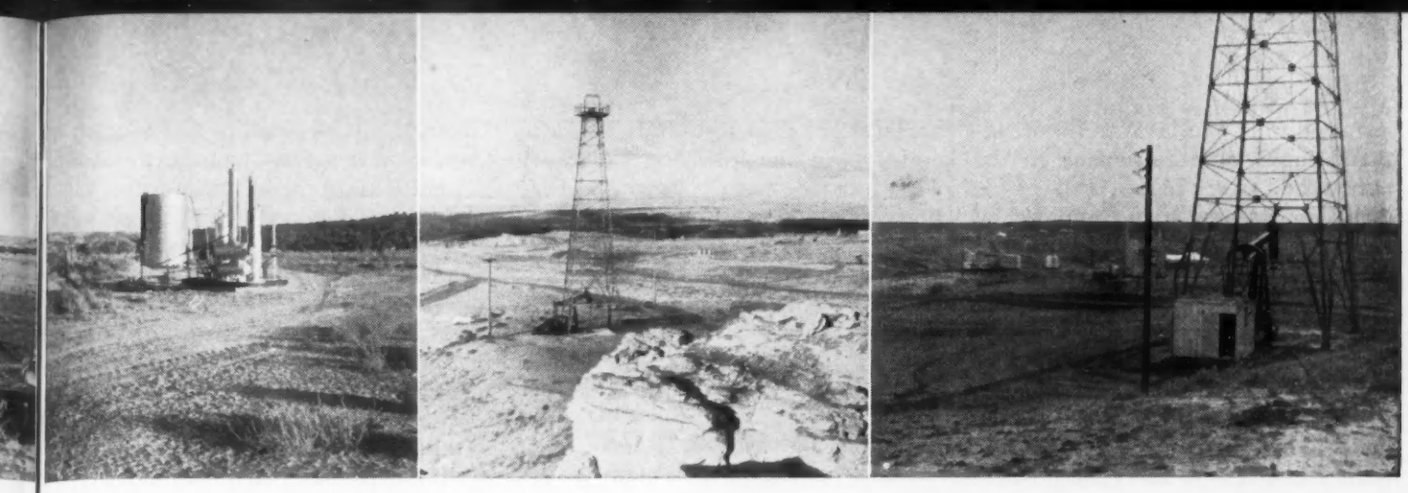
Oil is discovered and produced barrel-by-barrel, likewise gas is found and delivered cubic foot-by-foot. Wildcatters have to resolve imaginative ideas into mechanical methods which can be manually performed by technicians and unskilled workmen. Well locations have to be selected after geologists, geophysicists and engineers have worked as individuals or as teams; the proper formations have to be tested and proper completion precedes each discovery of oil and gas.

Wyoming's oil and gas industry since the Salt Creek days of World War I, has remained a leader in the 11 states of the Rockies, and its record for 1954 shows what sort of box score the "champ" maintained. Lahee in the *AAPG Bulletin* reports there were 21 discoveries and 169 dry holes among the wells drilled in search of new oil and gas fields. There were 59 discoveries and 210 dry holes among the wells drilled for extensions to existing fields plus the search for new fields. We can examine the methods used in discovering the 21 new fields which Lahee reports as follows: surface structure mapping, 1; seismic structure mapping, 9; combined surface and seismic structure mapping, 5; random drilling where accumulation was expected in sand deposits and stratigraphic traps, 6.

New techniques are being perfected from year to year, and we can never know when a technique will spread into an epidemic. Combinations of old techniques have been a steady trend over two decades. At the GSA meeting in Ottawa in 1948, Levorsen reassured geologists that the Leduc discovery in Alberta had not depleted the barrel of apples so much, as it would lead to the discovery of at least 10 or 15 new fields surrounding Leduc. Today's facts bear out his confidence in creative thinking. This creative thinking therefore must commence with today's knowledge. This was the vein followed by members of the Rocky Mountain Association of Geologists in Denver last year. The geologists published a very popular volume, *Oil and Gas Fields of Colorado, 1954.* They conducted a field trip to Canyon City, Colo., and visited the site of the first oil well completed west of the Pennsylvania fields. Other local societies have been encouraging this creative thinking. They published symposium volumes and guide books for comprehensive field conferences, including those at Albuquerque, Durango, Salt Lake City, Casper, Billings and Bismarck. The Rocky Mountain Section of the AAPG will hold its sixth winter meeting in Denver early in 1956, to discuss the tectonic structure of the territory and its effect on accumulation of oil and gas.

In addition to staff geologists who specialize in stratigraphic research, there are two companies who are doing creative thinking and furnish stratigraphic information on wells and areas as a complete service. One is headed by Mitchell in Denver and the other is headed by Hadley in Billings. This kind of geologic work is still new to the Rockies, although it was used extensively in the Mid-Continent almost 40 years ago. Correct stratigraphy is undoubtedly the work which is at the roots of all other data to be applied in the exploration for oil and gas. The progress we can expect in this endeavor throughout the Rocky Mountain states will result in more and more discoveries for years to come.

The geophysicists recently held in Denver their first national meeting apart from the geologists and paleontologists. Both company and contract crews are doing brand-new work through improvements in equipment and re-examination of old records. Obstacles overcome in the Rocky Mountain territory over the past 20 years have seemed insurmountable at times, but geophysics is at the threshold of locating buried structures,



producing wells in Grass Creek field, on western side of the Big Horn Basin in northwestern Wyoming. Note shallow zone central-power pumped well shown in foreground.

Mountain Fields

Numerous additional discoveries of oil and gas indicated for future.

Different types of traps found in formations of widely varying age.

Almost all modern exploration methods are employed successfully.

New drilling information leads to further discoveries.

buried stratigraphic traps, and other prospects which could not be done heretofore due to lack of equipment and experience.

A convenient way to examine the Rocky Mountain territory is to look at the basins and uplifts. The oil and gas pools within each basin and on the flanks of each uplift have many characteristics in common. On the other hand, the pools in different basins are often more unlike than similar in the geologic conditions which appear to be responsible for the accumulations of oil and gas.

Figure 1 is a regional map to help see the major features readily. The black circles or dots are sites of the oil and gas pools, and clusters denote the extensive fields. Dotted lines enclose the synclinal basins, which are named in bold lettering. Solid lines enclose the uplifts, anticlines, and mountain ranges, which are named in smaller lettering.

Williston Basin. Unfortunately space is lacking to discuss the stratigraphy by units smaller than the major rock systems. Starting with the Williston Basin in Montana, North and South Dakota, the oil and gas accumulations are in rocks belonging to Mississippian, Devonian, Silurian and Ordovician, respectively, with one pool possibly in Pennsylvanian rocks. To date the pools have been found in southwestern, northwestern, and northeastern areas, but none in the southeastern area. Chemical analyses of subsurface waters, water pressure-gradients, and other data from cores and well samples may become useful in explaining reasons for the occurrences and absences of oil and gas accumulations in wildcat wells drilled to date. Isopachs of interval from Greenhorn limestone to the respective horizons in Mississippian and underlying rocks may locate up-dip wedges of porous zones to go with micro-structures in subsurface, indicated by wells and seismic records. Other techniques will be tried all over the basin for new discoveries.

In north central Montana, the pools of the Sweetgrass Arch produce from rocks that belong to Cretaceous, Jurassic, and Mississippian systems, respectively. New Pools are being found in traps that are related to both stratigraphic changes and structural changes. In central Montana east of the Judith and Big Snowy mountains, the pools produce from rocks belonging to Cretaceous, Permian, Pennsylvanian and Mississippian (Chester) systems, respectively. Here the controls for accumulation of oil and gas range from purely structural to purely stratigraphic, with many pools combining the two. And here are found many anticlines with vertical closure which have been flushed with subsurface waters moving down a pressure-gradient surface away from the mountains. The flushing is complicated in some degree at localities where thermal waters occur.

Powder River Basin. In south central Montana, flanking the Big Horn mountains, the pools produce oil and gas from rocks belonging to Cretaceous and to Pennsylvanian systems under geologic structural conditions. And eastward in the Powder River Basin the oil and gas in rocks of the Cretaceous system are accumulated by combined structural and stratigraphic conditions.

This large basin is found chiefly in northeastern Wyoming. Here the pools are located completely around the flanks. Oil accumulations have been found in rocks belonging to Cretaceous, Jurassic, Triassic, Permian, Pennsylvanian and Mississippian systems, respectively. Controls of accumulation range from purely depositional and stratigraphic in Cretaceous sands on the east flank to chiefly structural at the southeast flank to a combination of both on the southwest flank. In each locality the lithologic facies of rocks in each of the respective systems mentioned is directly related to occurrences of oil and gas.

Therefore, in a single anticline only a few of the beds produce oil and gas, and the other porous beds are water bearing or have become impervious locally. On the flanks of the Powder River basin subsurface waters have flushed out the oil and gas at numerous anticlines, and have produced tilted oil-water contact surfaces in other instances. Most of the oil which has been produced to date in the Rocky Mountain territory has come from the Powder River Basin,

in fact during World War I, our national supply was dependent on the famous Salt Creek field.

Air photos have been examined by geologists to map surface structure covering the entire basin. In fact, comprehensive work by this method has covered Wyoming. Seismic mapping in the Powder River Basin has been useful in locating subsurface structure that is not visible at the surface and that has been found to trap oil and gas in a number of new pools. The 64 million-barrel reserve at South Glenrock is on an anticline without closure and as much as 3000 feet down the eastward plunging anticline, according to Curry in the *AAPG Bulletin*.

The Bighorn Basin pools occur in northwestern Wyoming and a slight distance into southern Montana. Their productive beds belong to Cretaceous, Permian, Pennsylvanian, Mississippian and Ordovician systems, respectively; and saturation has been located in Cambrian sandstone. This basin contains some of the nation's largest sulfur reserves being manufactured from H^2S gas. And the district, including the Bighorn and Wind River basins contains an important segment of the nation's black oil reserves, ranging from 10 to 30 degrees A. P. I. gravity in the stock tanks.

In former years, geologists were awed by the anticlines with 1500 to 3000 feet of effective closure. A number of these large features were found to have been flushed by subsurface waters, thermal in some localities. Seismic mapping has succeeded in locating anticlines with no closure or not more than 100 feet, which contained excellent oil reserves in stratigraphic traps. A number of these traps result from the lithologic transition laterally to the east from dolomite and limestone into red beds and evaporites in the Permian system.

Wind River Basin. The Wind River Basin pools in central Wyoming produce from rocks in the Cretaceous, Jurassic, Permian, Pennsylvanian and Mississippian systems, respectively. Accumulation to date have been attributed chiefly to structure with closure. Near the east end of the basin is located the deepest oil well in the Rocky Mountain territory, 16,603 feet.

Green River Basin. The Green River Basin pools are chiefly in southwestern Wyoming. One is in the northeastern corner of Utah, and several are in northwestern Colorado. They produce from beds in the Tertiary, Cretaceous, Jurassic, Pennsylvanian, Mississippian and Cambrian systems. In recent years the discoveries have been results of seismic mapping. The famous Lost Soldier district, adjacent to the Sweetwater Uplift, has one 1000-acre pool which has produced 46 million barrels of 36 degrees API gravity oil.

In the center of the basin is the Rock Springs uplift, which has about 10,000 feet of reversal. There is no true western flank of the Green River Basin, because formations at the western border of Wyoming have been thrust over the basin deposits. Middle Cretaceous sandstone formations with low permeability have been tested in recent years where the rotary drilling fluid is natural gas, and several oil and gas pools have been discovered. Tertiary rocks are productive in the pools straddling the Wyoming-Colorado boundary, where the accumulation is due to structural closure and lenticular sands.

Laramie Basin. East of the Snowy Range in southern Wyoming is the Laramie basin, where the pools produce oil, distillate and gas in rocks belonging to Cretaceous, Jurassic and Pennsylvanian systems, respectively. Structural controls have dominated accumulations found to date. About 20 years ago it was here the California Company succeeded in a wildcat discovery of oil, following up seismic mapping, to become the first operator in the Rocky Mountain territory so to succeed.

Denver Basin. The Denver Basin pools are located in southeastern Wyoming, western Nebraska and northeastern Colorado. The principal reserves are contained in a few pools. However, there are many pools containing one to eight oil and gas wells. East of the Front Range and Laramie Range of mountains, the pools are located on structures having closure measured in hundreds of feet. The east flank of the basin extends almost to the front of the mountains, with dips on the Cretaceous beds ranging from horizontal to 100 feet per mile. Here the micro-structures have relief comprising a few feet of reversal to a maximum closure of about 100 feet, found on Cretaceous sands near the base. Below the Cretaceous rocks there are a series of important unconformities. Triassic, Permian, Pennsylvanian, Mississippian, Ordovician, Cambrian and Pre-Cambrian formations are involved in paleo-tectonics and paleo-geology, very ably discussed by McCoy in the *AAPG Bulletin*, wherein he explains events which happened before the Denver basin began to be formed. The structures mapped on Cretaceous beds are sedimentary in origin and not tectonic folding, it is reported by many geologists. Oil and gas accumulations are all in Cretaceous sandstones, with the exceptions of three pools located in the west central area, where Permian sandstone is productive.

One of the peculiar sidelights on the area is the fact that a railroad flag-station has its name, Julesburg, firmly attached to the basin. Some reports hyphenate it with Denver. Apparently, it will always stick in the literature without any useful purpose.

On the eastern flank of the area the chief method of mapping has been seismic work, which has covered a large part in close detail and most of the area in correlation and sparse continuous profiles. Now velocity studies are being made with both the old and new records involved for re-contouring on members of the Dakota group of sands. Isopachs and detail subsurface maps are being made from the use of electrical logs and micrologs, five-inch scale. These formations contain large numbers of stratigraphic traps, only a part of which have been tested to date.

The Canyon City basin is indented at the southern end of the Front Range and has the oldest oil wells in the Rocky Mountain territory, one of which has produced more than a million barrels of oil in about 60 years from a fracture-reservoir in Cretaceous shale.

Las Animas Arch. The Las Animas arch in southeastern Colorado has a recent oil and gas well discovery, with accumulation in Pennsylvanian and Mississippian rocks. Straddling the Colorado-Kansas boundary is a gas pool producing from several formations in Pennsylvanian rocks. The future destiny of this district has been a wildcatter's imagination in the past, but seismic mapping and continued drilling of test wells may well cause many new pools to be found soon.

Uinta Basin. The Uinta Basin pools are located in western Colorado and in eastern Utah. They produce in rocks belonging to Tertiary, Creta-

ceous, Jurassic, and Permo-Pennsylvanian systems, respectively. Perhaps in no other place in North America are oil and gas accumulations so complexly related to geologic deposition or lithology, stratigraphy, and tectonics. On top of that, the famous oil shale beds are here, with shale oil resources equal to many million barrels of crude oil. Crude oil in fracture reservoirs in Tertiary shale and silts became an economic enigma to operators in eastern Utah. However, some progress continues, and there will be better days to come, perhaps, like the economic history of the Hugoton district in southwestern Kansas before and after pipe line construction.

The oil and gas pools along the southern flank of the basin are closely related to stratigraphic and lithologic conditions, but an important element too is local structure. The pools in the northeastern area are chiefly associated with structural closures and high relief anticlines subsidiary to the Uinta mountains and White River uplift. All of this country, the great length of the Uinta basin, is receiving more and more activity in anticipation of the benefits from construction of trunk pipe lines for both oil and gas.

Four Corners Area. The Paradox sedimentary basin and San Juan synclinal basin form the features we associate with the now famous Four Corners district. Once again we get into the superlatives when we discuss the potentialities of new oil and gas discoveries and resources. Pools in southwestern Colorado and southeastern Utah produce in Pennsylvanian rocks at the periphery of a huge salt basin, ably described in the *AAPG Bulletin* by Strickland and Wengert. The pools are associated with structure, lithologic lateral transitions, and stratigraphy. Surface structure and seismic structure have been used in selecting wildcat well locations.

The gas pool in the northeastern corner of Arizona makes that state the latest addition to the list producing oil and gas. It is conservative to suggest that a large number of pools will be discovered over the next several years in northeastern Arizona, where a study of well samples indicates existence of many stratigraphic traps in Pennsylvanian rocks.

The oil and gas pools in northwestern New Mexico produce from many formations in the Cretaceous and Pennsylvanian systems. Here the operators have developed one of the nation's important gas reserves in low-permeability sandstone of upper Cretaceous rocks, making up the chief portion of the cluster of black dots on the map in the San Juan basin. Steady and somewhat consistent progress in finding new pools by the majors and independents has been attributed to team work in wildcat drilling and use of both surface structure and seismic structure in selecting well locations. The big gas reserve is entirely depositional and stratigraphic in its classification of trap, so that subsurface geology was mapped as the field was extended.

Kaiparowits Basin. There are other basins and uplifts, but it seems well enough to conclude this article with the mention of only two more basins. In southern Utah is the non-commercial discovery well in the Kaiparowits basin. Here the lithologic transition laterally among alternating beds of limestone and sandstone in the Permian system is associated with oil saturation through a great interval of formations.

Great Basin. There is a pool in central eastern Nevada located in a Tertiary basin which has a north-south linear shape. These elongated basin separate mountain ranges of the Cordillera, and they cover a large district in eastern Nevada and western Utah, called the Great Basin territory. The crude oil accumulation was discovered in vesicular rocks of igneous origin but probably was partly or wholly water laid. At least these rocks could have been almost continuously fingered into fine sediments of continental origin. The oil is superficially similar to the oil seeping into Great Salt Lake on its northern shore. This remote pool challenges the imagination in its significance if a number of these elongated Tertiary basins should have undiscovered oil resources for tomorrow's wildcatter.

Within the 11 states of the Rocky Mountain territory the land titles range from U. S. Public Domain through various federal categories of re-acquired lands, U. S. Forests, Tribal Lands and Reclamation Lands with water control and power projects. The states have lands of the so-called school lands, re-acquired lands, in lieu lands and those connected with utility or irrigation projects. The private or fee lands comprise 30 to 40 percent of the entire area. The lease forms on federal and state lands are much improved with the tremendous activities since World War II. Leases on fee lands generally compare with Mid-Continent forms.

Railroad grant lands, including those held by Union Pacific and Northern Pacific, deserve a special treatise. However, the operators have made diligent efforts with these companies to work out drilling deals when geologic conditions caused well locations to be selected on or near their lands. The most significant phase of leasing today perhaps is the fact that most of the leases will be expiring by 1961; and that in some of the basins, millions of acres will have to be renewed at costs about 100 times as much as the original costs.

In most of the basins there have been many cases of unit operations. North Dakota has proration tied into market demand. The other states are concerned with well spacing and conservation of oil and gas along engineering methods.

On a small regional map like Figure 1, the distances between pools may seem short, but out on the ground we find the Rocky Mountain territory is about one-third of the United States area plus hills that rise as much as 6000 feet to a mountain pass. Those of us who have resided in the area many years do not expect to find all the oil and gas but are willing to leave that task to younger aspirants.

About the Author

THOMAS C. HIESTAND, who received an A.B. degree from Indiana University in 1921, joined Pure Oil Company in 1922; W. C. McBride, Inc., in 1927; and Indian Territory Illuminating Oil Company in 1936. He moved to Casper, Wyo., in 1943 with Cities Service Oil Company and to Denver in 1952 when he was elected vice president of Texota Oil Company.

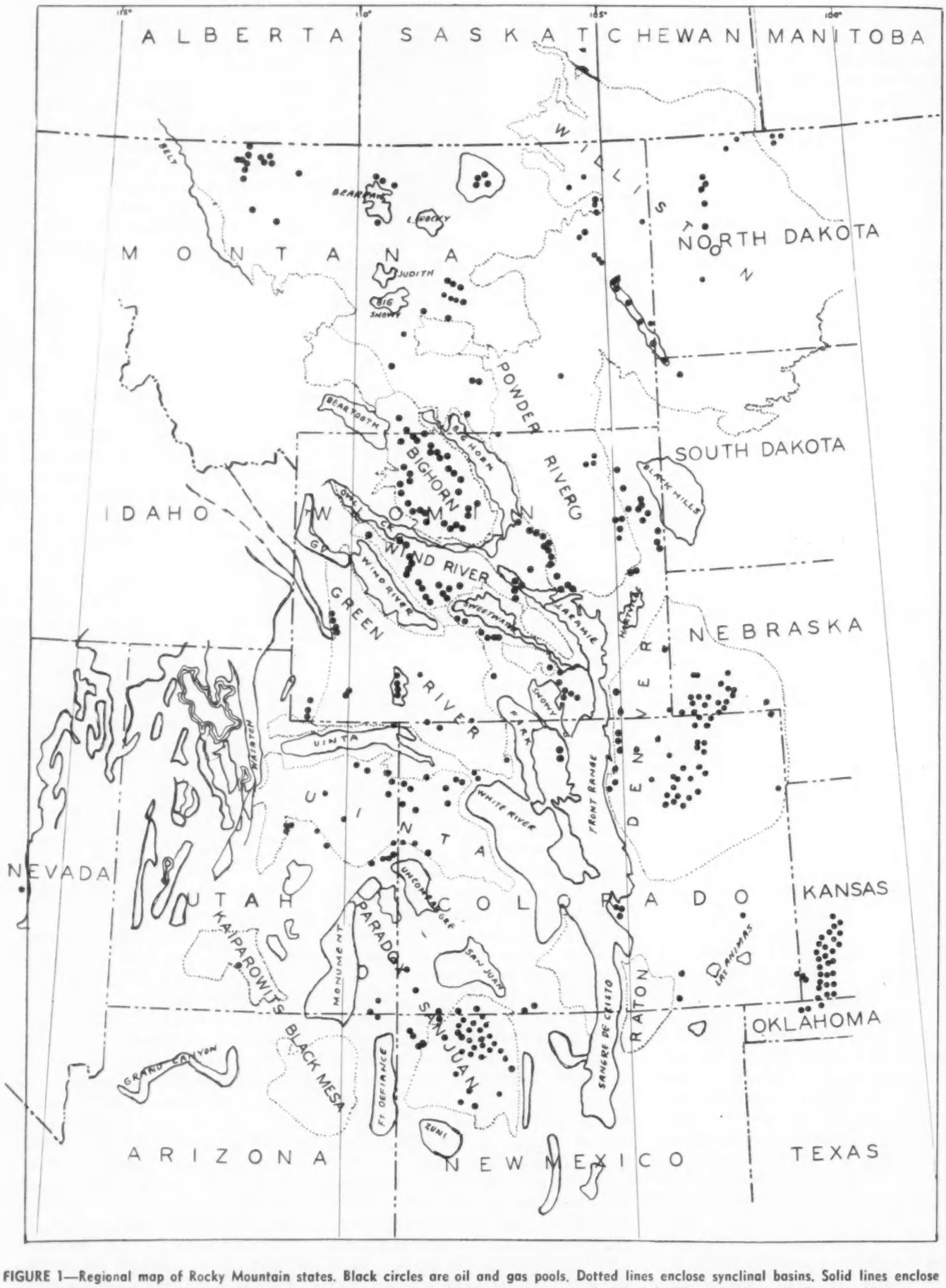


FIGURE 1—Regional map of Rocky Mountain states. Black circles are oil and gas pools. Dotted lines enclose synclinal basins. Solid lines enclose uplifts, anticlines and mountain ranges. Scale is approximately 80 miles per inch. Compiled by Thos. C. Hiestand, October, 1955.

ROCKY MT. BASINS ACTIVE

Over a dozen major geological basins afford vast areas of potential oil and gas production.

Most of the basins of the Rockies already are productive, and others offer good possibilities.

Current development is yielding important discoveries, and the success encourages expansion of activity.

Vigorous exploratory work and drilling are indicated for the future.

Comprising a virtual empire, 11 Rocky Mountian states have within their expansive borders over a dozen major geological basins. Most of those basins already are producing oil and gas, and the others have favorable possibilities.

Practically all of the basins currently are attracting active exploratory drilling. And the discoveries which are being made assure continued vigorous development.

Maps showing the basins of the Rocky Mountains appear on Pages 88 and 184-185.

Geological conditions in the different basins are discussed in this issue, beginning on Page 84.

In this article, the major Rocky Mountain basins will be discussed from the standpoints of current and prospective exploratory work and drilling activity, leasing, production, pipe line construction, and other development activities. These reports on the different basins concisely reveal what is happening currently in each basin and what is planned for the future in each of them.

Williston Basin Activity

THE BEGINNING of an upward trend in activity in the Montana-North Dakota portion of the Williston Basin appeared in the final months of 1955.

Success in prospects east of the Nesson anticline in North Dakota is partially responsible. Long range planning, now apparently ripening to action, also seems to be a contributing factor.

The year opened with encouragement east of the Nesson anticline in North Dakota only in Bottineau County. There, new drilling produced successful stepouts and a new field. Later drilling did not develop the volume of production promised by earlier tests, but the programs generated east and southeast of previous production there held up well.

A seven well program scheduled by Lion Oil Company in this area, plus additional drilling by Amerada Petroleum and by several independents, advanced activity and held the total activity in the first half of the year to only slightly less than in the previous year.

It remained for a discovery by Sohio Petroleum in Renville County, between the Nesson anticline and Bottineau County production, to indicate that the "discovery of consequence east of Tioga-Beaver Lodge," which had so long been awaited, might have been made. Sohio completed the Ritter 1, for 374 barrels of oil per day from the Mississippian. Geologists express the opinion that the reservoir may be due to reefing, perhaps of a local nature, and not to the pinchout often advanced as the most likely trap for Eastern Williston Basin oil. Confirmation drilling was started in November, with evaluation of the field not yet possible.

In Burke and Ward counties, 26 miles northeast of Tioga, Calvert Drilling began, a series of 10 wildcats this fall, on farmout from Stanolind Oil & Gas. The first in the series was a discovery in the Mississippian. Confirmation drilling is in progress. Noncommercial shows in another Burke County well are already reported.

The Texas Company opened the Blue Buttes pool, on the Nesson anticline in McKenzie County, seven miles southwest of Sanish with Madison production from 9300 feet.

At the end of September, North Dakota's score for the year showed four discoveries completed, another testing. Forty-eight wildcats had been completed. The state had 181 wells completed in the nine months, with 119 of them oil wells.

New work of importance included a slim hole series from truck mounted equipment started in Calvalier County, far to the east, by The Carter Oil.

On the west side of the Basin, The Pure Oil had a failure 32 miles west of Tioga field, with penetration to

the Madison. A deep wildcat in the Fryburg area of Billings County failed, but a projected 13,400 foot test in the central basin area, six miles east of the Montana border in McKenzie County, cored Madison shows. This well is Gulf Oil's Bennie Pierre-Federal 1, 25 miles southeast of Red River production at Brorson, in Richland County, Montana.

North Dakota exploration to the west of established production coincides with increased Montana activity east of the Cedar Creek anticline. Two discoveries on the anticline, and successful completions east of it were of major interest in Montana. Also significant was the announcement of confirmation drilling at Lion Oil's (Monsanto Chemical) Wibaux discovery in Wibaux County after a year of production history.

Drilling through eastern Montana was geared to the coming of the new outlet. Construction of the Butte pipe line (Murphy-Shell-Northern Pacific), from East Poplar along the Cedar Creek anticline and south to a junction with the mainline crude carriers and then east in Wyoming, neared completion in November. More than any other one development this pipe line provides a firm foundation for future activities in eastern Montana.

Estimates of 30,000 barrels per day of producible crude above existing transportation facilities in the Eastern Montana area were reported. The line is to begin operations at or near this level. Development drilling has been done steadily in East Poplar and along the Cedar Creek anticline (Pine and Cabin Creek fields in particular) since the line became a certainty.

Montana had 12 discoveries completed in the first nine months of 1955, the result of 102 wildcats. A total of 257 wells, at that time, was slightly higher than the year before and included 121 successes.

At the south end of the Williston Basin in South Dakota, a substantial slim hole stratigraphic test series aimed at evaluating a broad area through the central and north central portion of the state continued through the latter half of the year. Shell Oil, The Pure Oil, and Herndon Drilling were among the more active operators.

Away from the Williston Basin, but associated in operations with it, is the increase in activity through central and northwest central Montana. Wildcat programs through Musselshell, Rosebud, Valley, Hill and Glacier counties continued throughout the year. With the exception of Glacier County, this exploration is to shallower depths than in the Williston Basin area.

Encouragement came with new pay zones and successful stepouts at Northwest Sumatra in Rosebud County, where Montana's most active development program has been conducted during the past two years.

In Yellowstone County's Wolf Springs area, 24 miles south of Northwest Sumatra a 386 barrel per day Amsden discovery by Atlantic Refining, in August, added to the interest in this formation through central Montana.

Drilling in the general Glacier Park area in Glacier County promised a solution to the riddle of Montana's Disturbed Belt early in the year. But Union Oil's apparent discovery in the area was suspended after extensive testing, as other wells with good shows have previously been suspended.

Far from ending the interest in this area, this deep test increased it. Interest in Blackfeet Indian lands in the area is still high as shown by sales held during the year. Several operators, among them Shell and Continental have substantial holdings in the belt, and are reported planning activity in the relatively near future.

Montana state lands came back on the market during the year, as a result of the U. S. Supreme Court decision which blocked attempts to impose unusual conditions on leases of state lands.

In October Montana had 39 active rotaries, more than half of them in the Williston Basin area. North Dakota had 22 and South Dakota 3.

Lands in both North Dakota and Montana have been held through the slow period of the past two years, Farmout programs will now increase in intensity, especially in the shallower areas, and more especially toward the east side of the basin in North Dakota. The slim hole technique, with mobile equipment in areas where Ordovician is at about 3000 feet, seems certain to increase in use.

The area will finish 1955 strong. Had 1955 results been less encouraging with the opening of fewer new areas, 1956 might well have opened slow. But encouragement has been found, and 1956 will open strong as soon as weather permits.

Regionwise, the Renville County, North Dakota discovery, and that at Wolf Springs in Montana, are to rank with the most important in the Rockies in 1955. Each contains promise beyond the purely local limits of the field.

Operations wise, the concentration of offices in Billings rather than the split between Billings and Bismarck will not materially affect work in any one area.

Big Horn Basin

THE BIG HORN BASIN is the smallest in areal extent of the major Rocky Mountain basins, but is the most prolific producer of oil. Many of the basin's fields are producers of black oil, and with the greater demand for highway materials, and ready transporttaion to market, these fields have enjoyed good production rates, plus a price increase in 1955.

In previous years a considerable amount of exploratory attention has been directed to the deeper central prospects of the basin. In 1955 successful emphasis in drilling was placed on the flanks. Meyer Gulch and Water Creek fields, in Washakie County were eastern flank discoveries. The former, discovered by Superior Oil's Govt.-Chittim 1, C SW SW 29-47n-90w pumped 100 bopd from the Phosphoria. The Water Creek discovery was Sohio Petroleum's State-Unit 1, SE SE SE 36-44n-91w, a 328 bopd pumper from the Phosphoria.

Most significant of east flank developments, however, was the discovery of oil and gas production in the Muddy sand in the Manderson area. This formation had previously been overlooked in search for Phosphoria and Tensleep oil. Establishment of

this pay in South Manderson led to the recompletion of several wells on the Manderson structure by Mobil Producing. Following evaluation of these wells and the recompleted from Phosphoria to Muddy, a substantial development program to muddy sand production in the area is a possibility.

The basin also had discoveries at Northwest Byron, at Bearcat Unit in Park County, and in the Oregon Basin area, the latter was a new pay. None of these discoveries were spectacular.

Development drilling has been steady but not at extremely high levels during 1955. Big Horn County had 29 wells, Park County 26, Hot Springs 22 and Washakie County 9. A total of 22 wildcats was completed in these counties in the same nine-months period.

The acceleration of Big Horn Basin activity from 1951 through 1953 was due to market outlet expansion. The situation is now more stable, and without the pressures to immediate action felt in some of the newer Rocky Mountain areas. It is significant that leases have geen generally held throughout the basin, including the deep central area. More exploration is certain on these lands. The most recent activity in the central areas was the 14,000 foot drilling southwest of Worland. In 1955 deep drilling, in the Heart Mountain area of Park County on the northwest side of the basin, was the principal deep activity. Any deep success in this basin will cause a renewal of wide scale exploratory work.

Powder River Basin

THE POWDER RIVER BASIN is one of the Rocky Mountain region's oldest producing basins and the first to gain wide scale recognition for the Rockies as an oil producing area on a substantial scale. It remains, after more than a half century of producing history, one of the most active and rewarding areas in the region.

Salt Creek and Big Muddy, on the west and south flanks of the Powder River are the early fields of considerable prominence for the region. From these two fields grew much of the region's strong position in the oil producing industry during and after the first world war.

Exploration in the Powder River Basin began the resurgence of the Rocky Mountain region in the oil industry following World War II.

Today this basin still contains a great deal of practically unexplored acreage.

Sussex, Meadow Creek, Glenrock, East Big Muddy, and the Mush Creek-Skull Creek developments on the east side of the basin were the major discoveries and the principal centers of Wyoming activity 1946 through 1950. Development of some of these fields continued much beyond 1950, accounting in great measure for Wyoming's lead in total drilling activity in those years.

Drilling in the Clareton Trend, where more than 50 rigs were active at the height of development, slackened in 1955. Production problems in the gas drive reservoir were largely responsible. In the area's early development there was insufficient crude outlet. This situation was remedied, but was followed with the gas/oil ratio problem, which is still being studied. At one time it was estimated that five years of drilling at the 1954 (50 rig) rate was available within the Trend area. Depending on solution of current problems, it is still doubtful whether that pace of development will again be reached, but additional development is likely over a longer span of time, and in a more leisurely fashion.

Before 1953, Powder River Basin production was limited to the west, south and east flanks in the southern half of the basin. Exploration in that year brought shallow production at Ash Creek in Sheridan County. A considerable development program, and further exploration has followed. South Ash Creek, in 1954 was a second discovery. Through the first nine months of 1955, 24 development wells, including 17 producers, and 13 wildcats, all failures were drilled in this county.

The total drilling picture for the Wyoming portion of the basin in 1955 broken down by counties is as follows:

County	Comp.	Oil	Gas	Dry
Campbell	6	0	0	6
Converse	24	19	0	5
Crook	13	4	0	9
Johnson	46	28	0	18
Natrona	30	18	0	12
Niobrara	21	7	0	14
Weston	168	107	1	60

With the exception of Sheridan, Campbell, and Crook counties this drilling represents development in older areas, and search for new production in fringes of older producing areas.

Approximately half of the 103 rigs credited to Wyoming activity in late 1955 are active in this basin.

With the discovery of oil in 1953 at Ash Creek, more than 100 miles north of previous production, there followed a new interest in the northern Wyoming-southern Montana area of the basin. Continued light exploration of the Montana area was unsuccessful until completion of a gas discovery in the Pumpkin Creek area of Montana's Powder River County early in 1955. This discovery was made by George J. Greer, Trustee. It was followed by an agreement between Greer and El Paso Natural Gas which resulted in a 20-25 well series through the Montana basin, with the series still in progress. Additional discoveries and development producers have been completed, but data has not been completely released on the series.

Production at Ash Creek was from Ash Creek (Shannon) sand. The Montana discovery was in Eagle (Ash Creek-Shannon) sand. Producing depths ranging from 2500 to 5000 feet in these fields; and they have initiated a new phase of development in the basin.

The second phase of Powder River Basin work is deeper tests in the central portion of the basin, where some potential horizons are well below 12,000 feet. Recent locations for deep tests in Johnson and Converse counties in Wyoming are most recent additions to the continuing search for deeper production in the basin.

New rank wildcats have been staked in southeastern Montana and in the north end of the basin in the Miles City area. This area may expect an increase in activity through 1956.

The Platte and Service crude lines traverse the southern end of the basin. The Butte pipe line, southward to them from eastern Montana is being

completed. There is no longer a crude outlet problem on an important scale.

The Powder River remains one of the most interesting and promising of Rocky Mountain provinces for future work. It has been one of the most valuable contributors to Wyoming's regular annual lead in reserves additions among Rocky Mountain states.

Wind River Basin

THE WIND RIVER BASIN is the cradle of Wyoming commercial oil production. The Derby-Dallas area of Fremont County had production in 1884. Exploration and development in this basin has continued since that time.

Within the basin, the range of producing horizons runs the gamut from Cretaceous through Mississippian. Development of the flanks has been the pattern in this basin, as in others of the region, with deeper drilling following extensive seismic work.

The basin had what is still regarded as the most potentially important discovery of the year in 1954. This was Forest Oil's Grieve Unit discovery in the southeastern portion of the basin, 35 miles west of Casper in Natrona County. Production was found on the 25,000-acre unit in the Muddy zone of Thermopolis shale, so classified since it is older than the true Muddy producing formation in other Wyoming fields.

Six producers have been completed in this field, with gages ranging from 900 to 1500 barrels per day. A gas discovery, also within the unit is now testing.

The southeast end of the basin had a discovery in 1949 at West Poison Spider, with Mesaverde production found at about 10,000 and Frontier production at about 14,000 feet. The West Poison Spider field represented deeper exploration of an area which has been producing (Poison Spider, Oil Mountain, Iron Creek) since 1917. For a time, Frontier production at this field was the deepest in the world at 14,307 feet. In 1951 deep drilling in West Poison Spider accounted for the second deepest well (16,605 feet) in the state. Oil was recovered from Frontier and from Morrison, but not in commercial quantities at this depth.

The Grieve Unit discovery, plus another at Bates Hole on the southeastern edge of the basin turned attention to shallower prospects. During 1955 a considerable amount of exploration has been carried on in this area, without however, another discovery of any considerable caliber.

Deep work within this basin has not been neglected, as proved by Phillips Petroleum's current wildcat in the Boysen area of Fremont County (27-5n-5e) where Mesaverde is the objective below 12,500 feet. The well was drilling below 12,800 in early November, with some shows reported, but not confirmed.

Through September, 44 wells were completed in Fremont County, most active within the basin. Twelve were wildcats, and of the 32 development wells, 24 were successful.

Uinta-Piceance-Green River

NORTH OF THE San Juan Basin origination of the Pacific Northwest pipe line, the Uinta-Piceance basin in Utah and Colorado and the Green River Basin in Wyoming offer a wide area of potential oil and gas production. In these basins activity has also taken a considerable recent jump with the prospect of outlet for developing gas production.

The potential of these basins has long been demonstrated. Rangely, largest of Rocky Mountain fields, lies within the Uinta-Piceance. Gas production has been established and shut in in some areas (Piceance Creek, etc.) for more than 25 years. Tertiary production in Utah at Red Wash and Walker Hollow in Uintah County has been developed during the past 10 years. At the west edge of the basin the Wasatch Plateau has had successful exploration for gas at Clear Creek, and at Peters Point.

The gas produced with oil at Rangely, and the shut in fields in the general western Colorado area figured, along with more recent developments such as Twin Buttes in Garfield County in the planning for the Pacific Northwest pipe line.

Gas production through the Uinta-Piceance is found in Dakota and Morrison, generally speaking. Oil is found in Wasatch (Tertiary) through Pennsylvanian (The Weber at Rangely).

Older production is in the Piceance and on the east side of the Uinta basins. Drilling in the Tertiary areas of the basin is expensive, running upwards of $400,000 per well in some of the fields within the basin. High pour point (100 degrees) oil has made special heating equipment necessary, as well as arrangements for special transportation.

But the present trend of development has put the accent on shallower areas of less expense. Utah's Grand County, and the southern edge of the Uinta Basin has had a half dozen gas discoveries during the past 12 months. Potentials range from one to 20 million cubic feet per day. Production is from Dakota-Morrison, above 3000 feet in most cases.

In Wyoming's southwestern quadrant, the Green River Basin has long been known as a possibly important producing province, has not had the degree of exploration prevalent in the rest of the state. Early gas production was found in the overthrust area on the west side of the basin in the Big Piney area.

This development is in shallow sands. In 1951, General Petroleum found oil in Nugget in the same general area at considerable (10,000 feet) depth.

The basin, which extends into northwestern Colorado has areas of great depositional thickness. For example, in the Pacific Creek area of Sublette County, Wyoming, Superior Oil drilled

what was until 1954 the world's deepest well. At total depth of 20,521 feet, it was in upper Cretaceous.

The basin has only been spotted with exploratory wells. A considerable program was expected to develop rapidly with plans for Colorado Interstate Gas Company's line to join with Pacific Northwest at Green River, cross the basin eastward to serve Denver. Drilling has increased, but the increase gave indications of reaching major proportions only late in 1955. Expectation for 1956 includes heavy drilling through much of the basin's area.

Production is found at great depth extremes. In the Big Piney area a shallow well blew out in 1953, was gaged at 73 million cubic feet per day before being controlled. It was completed in a part of the section at less than 1100 feet, total depth. By contrast, Mountain Fuel Supply produces gas from Dakota in the Church Buttes field below 13,000 feet.

Leasing, particularly during the past two years has been heavy, and has been largely a major company play.

Important 1955 discoveries have been made at Pinedale anticline in Sublette County by Continental Oil-El Paso Natural Gas-Malco refineries, and at Hogsback Unit, Sublette County, by General Petroleum.

Denver-Julesburg Basin

THE IMPACT of the Denver-Julesburg Basin on the developing oil industry of the Rocky Mountain region since 1949 is difficult to over estimate. Despite characteristic Cretaceous production of usually limited extent in the various fields discovered, the basin has become the region's leading area of activity.

In 1954 it had 41 percent of all wells completed in the Rockies. This included both Colorado and Nebraska, and the limited amount of drilling in the southeastern Wyoming portion of the basin.

In 1955, the basin's share in total regional drilling will be at least as large, perhaps larger. By end of the third quarter of the year, Colorado had 1080 completions, the great majority in the basin. The state took the lead in footage drilled, with nearly 6 million feet. Western Nebraska in the same period had 588 completions, considerably more than in all of 1954 (458), and was second in footage drilled with nearly 3½ million feet. This was nearly a quarter of a million feet more than was completed in Wyoming in the same nine months, marking the first time that Wyoming has dropped from either first or second place in footage among Rocky Mountain states.

The tremendous increase in Nebraska activity in 1955 is one of the outstanding features in regional as well as Denver-Julesburg Basin activity. Development to the north in the Harrisburg area, and a much increased rate of drilling in Kimball County, plus new work in Morrill County, and further north along the Chadron Arch is responsible. A majority of this work is by independents. Meanwhile, a very good success ratio was maintained in exploratory drilling, with nearly 16 percent success.

Before 1953, all production in the Denver-Julesburg was Cretaceous. In that year production was found in the Lyons (Permian) sand in Weld County, Colorado. There resulted a considerable amount of deeper (9-10,000 feet) drilling through much of the northwest portion of the basin. While the original pool continued successfully to develop, there was no additional pre-Cretaceous discovery until 1955, when another was made in Weld County, four miles from the first Lyons production. Deep prospects are again being actively considered.

Exploration south and east of older trends continued in 1955 with discoveries in Adams, Washington and Jefferson counties in Colorado. The latter discovery was southwest of Denver along the mountain front, and at nearly 10,000 feet. While it has not proved of major consequence, the discovery is expected to have a considerable bearing on continuation of future work toward the west flank of the basin.

Two Wyoming discoveries within the basin in 1955 put a different complexion on the Denver-Julesburg's northwest corner, which had been previously pretty much let alone by comparison with Colorado-Nebraska areas.

These discoveries were south of Torrington in Goshen County, and in the Pine Bluffs area of Laramie County. Both produced from the usual D or J sand series of Dakota.

A much expanded drilling program through this area is in progress, and has probably by no means reached its zenith.

The Denver-Julesburg Basin began its modern development in 1949 with a discovery in the Gurley area of Cheyenne County, Nebraska. Development has spread steadily southwestward, with the line of southwestward advance also steadily broadened to east and west, as noted.

Fields of substantial nature have been discovered at intervals adding to the interest shown in the smaller and more common fields. Among these are Little Beaver, Badger Creek, Plum Bush Creek, Adena and Cliff fields in Colorado, and Long and Travis fields in Nebraska. Earlier good producers are Yenter, Walker and Mt. Hope.

Crude outlet restricted drilling rates from 1949 to 1954. A jump in drilling resulted from completion of the Platte pipe line in 1953. This filled available line capacity from the basin with new crude developed by accelerated drilling. In 1954 construction of the Arapahoe pipe line rerouting and expansion of Service Pipeline facilities again made new outlet available.

Drilling was stepped up to present levels. Although the basin is not one of the largest in the region, the fact that a failure condemns only a small area, has allowed for a very intensive program. The high rate of activity of 1954 and 1955 can definitely continue for some time, since the older areas continue to pay off, and new areas such as southeast Wyoming and extreme western Nebraska have been added.

This together with expansion of producing area to south and west in Colorado, plus fields of the caliber of Adena (16,000 bpd) maintains the Denver-Julesburg Basin.

There is now in progress a spread of exploratory interest to the southern flank of the basin along the Las Animas Arch, as well as a similar expan-

sion to the east and north along the Chadron Arch in Nebraska. While these plays may well transcend the geological limits of the basin, they must be associated with its development from an economic standpoint.

This is also the case with the recent apparent discovery in Hitchcock County, Nebraska. It is on the Cambridge Arch, 100 miles east and south of Denver-Julesburg production, and is in Pennsylvanian, but comes under operational facilities of Denver-Julesburg activity.

Many operators now active in the Rockies have entered the region, and found their first production, in the Denver-Julesburg. They have later branched out to other areas. Many new operating companies have been formed in the basin. Some of these have reached considerable stature.

Drilling-wise, the basin has not accounted for a majority of the region's rigs. The short time required for completion allows more holes in a given time with fewer rotaries. All of Nebraska's 36 active rigs are in the basin, as are the majority of the 65 units now active in Colorado.

San Juan-Paradox Basins

These two basins, occupying the northwestern corner of New Mexico, south edge of western Colorado (San Juan) and the southeastern portion of Utah and parts of Southwest Colorado (Paradox) have had exploration for many years. More than 20 years ago gas was found in several areas within these basins.

Development has been relatively recent in the San Juan, has only just started in the Paradox.

The two basins, particularly the Paradox, contain one of the most important "frontier" areas of Rocky Mountain exploration. New outlet for gas is the basis of development at this time.

Gas production in the San Juan began on a large scale with completion of pipe lines to El Paso, Texas, later to the west coast. El Paso Natural Gas Company, responsible for these lines, has been the leading force in the development of extensive gas reserves in the basin. Large reserves have been developed in the Blanco pool in New Mexico, with lesser activity in southern Colorado.

The apparent extent of Cretaceous gas production in this basin gave rise to the proposal for the Pacific Northwest pipe line, to offer another outlet for San Juan gas, and to allow development of possible Paradox reserves, as well as indicated reserves along the entire west slope of Colorado and in eastern Utah-southwestern Wyoming.

When this line was announced, extensive drilling in the San Juan resulted in 626 wells completed in 1953. This was a jump from 347 in the previous year. The line had long drawn out negotiations and hearings, and its status was in doubt through 1954, with a resulting drop in well completions in the basin to a total of 387. A good portion of this total was drilled on lands committed to the new line.

Through the first nine months of 1955, the commencement of construction on the Pacific Northwest line was apparent, with 406 northern New Mexico wells completed by the end of September.

San Juan gas completions are at 3000 to 5000 feet generally, with production from upper Cretaceous. Principal activity of the past two years has been the eastward expansion of the Blanco producing area into Rio Arriba County. Several potentials of 20 million cubic feet per day or better have been reported in this eastward trend, comparing favorably with the much smaller average potentials through older areas. In fact, through much of the basin, completions for less than a million cubic feet per day are common and are commercial because of relatively shallow depth.

There is oil production spotted through the basin, but it has nowhere developed to major significance. A recent discovery in Gallup sand southwest of Blanco gas production has been testing, with El Paso Natural not having released a gage officially. Its impact was keenly felt at a recent land sale by the Navajo Indians. A bid of $726.94 per acre was made for a 160 acre tract offsetting the discovery. Other nearby acreage went to $200 or more per acre in bonus bids. The possibility of an oil development in this basin has been definitely opened. Meanwhile, it remains as the site of one of the nation's greater gas reserves, and is to be subject to extensive development over a period of several years as a result of new pipe line outlet.

The Paradox Basin, northwest of the San Juan, has also profited greatly from the new pipe line, although the majority of success to date has been oil production.

A majority of wells drilled in the basin have had shows in Paradox (Pennsylvanian). But until recently there have been no successful completions. The modern development of the basin brought discoveries at Desert Creek and East Boundary Butte (Arizona) in 1954. The first is a Pennsylvanian oil discovery by Shell. Shell also drilled the East Boundary Butte discovery, Arizona's first. It was a small gas discovery. In 1955 came another oil discovery at North Boundary Butte, also by Shell, and a gas discovery by Humble in the Boundary Butte area of Apache County, Arizona.

A gas discovery southeast of Monticello by Gulf Oil in mid 1955 was shut in after a flow of 10½ million cubic feet per day from Paradox. Also in San Juan County, and north of this well, White Canyon Mining has completed a smaller (2 million cubic feet per day) gas discovery. Additional work is in progress in both areas.

Much of this area is within the Navajo-Hopi reservation. When large amounts of Indian acreage were offered for lease in 1953, widespread interest was revealed in bidding. Shell Oil alone spent more than $3 million for Indian lands. Other companies, including a majority of the majors, also bought heavily in the area. Total land investment is estimated at more than $10 million in the southeast corner of Utah alone.

In addition to Shell and Humble, others drilling in this basin now include Carter, Stanolind, Sinclair Oil & Gas, Gulf, Ohio, and Reynolds Mining, a Reynolds Metals subsidiary, and El Paso Natural Gas.

The Paradox Basin has progressed far enough in the past five years to assure much increased activity, possibly with extensive reward over at least the next five years. —**The End**

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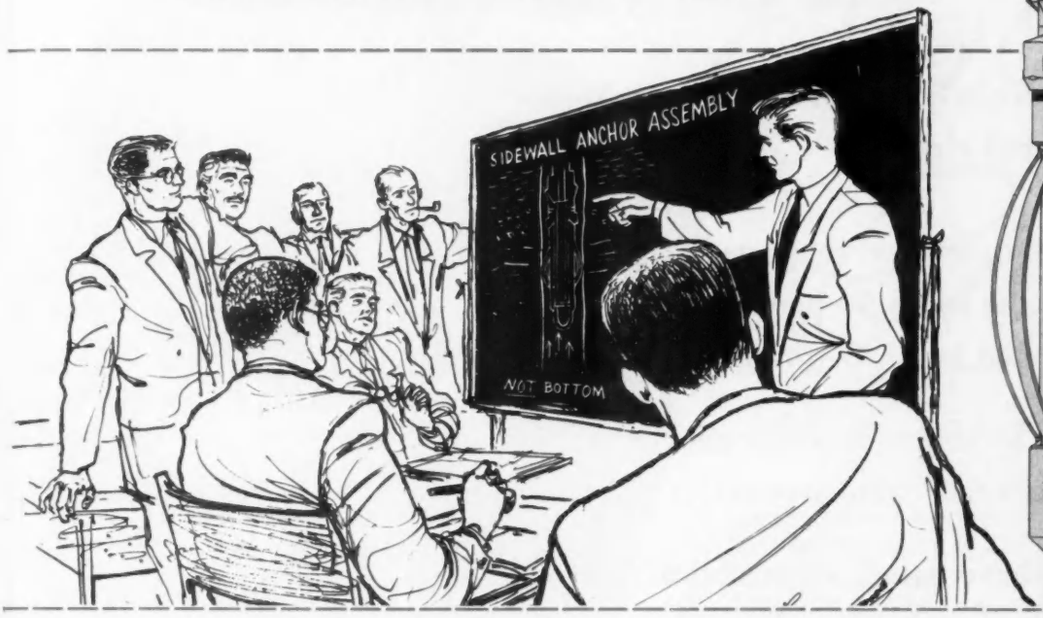

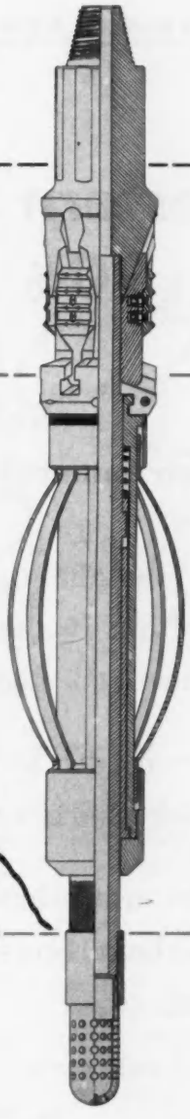

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THE CHANGING PANORAMA

11 Western States Want 90% Mineral Royalties

Nearly all of the other 37 states retain their mineral rights.

Rocky Mountain Association supports federal legislation to return to the states 90 percent of the royalty monies now collected by U. S. government.

Funds are needed by states for public education, highway maintenance, other state services.

Mountain states have same responsibilities as other states without benefit of mineral royalties received by the others.

About the Author

FRED E. WOODRING graduated from the University of Pennsylvania with a degree in Business Administration and took postgraduate work at LaSalle University in Chicago. In 1936, he joined Sun Oil Company as seaman assigned to a tanker plying between Philadelphia and Texas. He resigned as traffic coordinator from Sun in 1948 and the following year was appointed executive secretary of the Wyoming Trucking Association. He became affiliated with Rocky Mountain Oil and Gas Association in 1954 serving in his present capacity as executive vice president, coordinating the activities of the seven Rocky Mountain states served by the Association.

By FRED E. WOODRING
Executive Vice President
Rocky Mountain Oil and Gas Association

THE OIL INDUSTRY in the Rocky Mountain region is faced with a peculiar problem. Whether to pay a 12½ percent production royalty to the federal government, or to the state from which the production came.

In 11 western states a very large part of the lands are owned by the federal government as Public Domain or acquired lands. In other cases, only the surface is owned by the rancher and farmer, with the mineral rights retained by the government. Nearly all of the other 37 states own their public lands outright, and retain mineral rights. Royalty revenue from oil and gas production from government owned lands in these 11 western states goes to the government. Of this, 10 percent is retained in the federal treasury; 37½ percent is returned to the states of source; and 52½ percent goes to the reclamation fund.

The history of the public lands in the U. S. shows that it has always been the intention of Congress to treat all states equally, and that the public lands should be administered for the benefit of the citizens of the individual states which include those lands. When the states have not handled their own public lands, the U. S. has been considered a "trustee" for the benefit of the states.

Legislation before Congress proposes to carry out that trust. Through this legislation the western states will be treated more fairly by paying the royalty monies now collected by the U. S. government to the states for public education and maintenance of highways, with a payment of 1 percent royalty to the record surface land owned by the state.

The bill, introduced in the Senate by Senator Frank A. Barrett (R-Wyo.), and a similar bill introduced by Representative Keith Thomson (R-Wyo.) would return 90 percent of the mineral resource dollars to the 11 western states, leaving 10 percent in the federal treasury for cost of administration.

Rocky Mountain Oil and Gas Association has gone on record as supporting the principle of the Mineral Royalties Bills as amended. The Association is of the opinion that the oil industry, as well as the people in the Rocky Mountain region would benefit through the passage of the bills in these ways:

1. Education. Facilities for education of petroleum engineers, geologists, and geophysicists, and representatives in every phase of the oil industry, as well as a better educational program for the children of the oil workers employed in the western states, furnishing opportunities more equal to those supplied in the wealthier and more populous eastern states.

2. Highway maintenance. Through

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a comprehensive highway maintenance program, more transportation problems will be solved; oil fields will become more accessible and hauling rates will become less costly.

3. Taxes. If the western states were to have the additional income of the mineral royalties, the tax burden on the industry and its suppliers should be relieved substantially. For example, the state of Wyoming would have an additional income of $20 million annually, instead of the present yearly receipts of approximately $7.5 million. Money presently channelled to education and highway maintenance could be used to defray other obligations for state operations.

As matters stand now, the state has the full burden of education, fire and police protection, road and highway maintenance, the support and operation of all other state institutions, and every function inherent to a state, without benefit of the financial aid of total mineral royalties. It is possible that, without further taxation, the states will be unable competently to fulfill these obligations.

Further taxation would place an additional burden on the oil industry, as well as other taxpayers, either through a state income tax, or through other forms, such as taxes based on the production, transportation and marketing of oil and gas.

The Congressmen from Wyoming feel that the 10 percent to the federal government should cover the "trustee fee" and support the administrative costs, in order to continue the present centralized and well-understood procedure of federal land leasing, as contrasted with separate, and differing, regulations of the various states.

To support the legislative action, an educational program will be necessary, both within and outside the oil industry. Rocky Mountain Oil and Gas Association will seek to inform those people most vitally interested of the benefits to be gained by the passage of the bills. The Association feels it is necessary for the people to realize that the western states must be the equals of the other states in the Union as Congress always intended, rather than a species of colony for national exploitation. —**The End**

Oil Demand Due to Rise 4.3 Percent During '56

• To meet requirements, new supply will need to be increased by more than 400,000 barrels daily.

• Domestic producers and importers will have this additional market to divide between them.

• Market opportunities will be good, but competition will be keen, and selling must be aggressive.

MARKETS FOR oil and gas will continue to expand steadily in coming years. And 1956 will bring a normal expansion. But the gains in business volumes in 1956 may appear moderate in comparison with the exceptionally sharp increase of 1955.

Market opportunities will be good in 1956. But competition will be keen, and selling efforts will have to be aggressive to be fully successful.

These statements summarize briefly the recently revealed forecasts of several well qualified economists.

"Market opportunities will be larger than ever in 1956, but selling will have to be more skillful," predicted Walter E. Hoadley, Jr., treasurer and economist of Armstrong Cork Company, Lancaster, Pennsylvania, in discussing the general economic outlook for 1956 at the annual meeting of the American Petroleum Institute in San Francisco.

"New products may well be needed," he added, "as insurance to bridge temporary soft spots in demand for existing products."

At the same meeting, John J. Winger, petroleum economist, The Chase Manhattan Bank, New York, agreed that in 1956 business volumes would increase further but less sharply than in 1955. He said that petroleum consumption has become increasingly sensitive to general business trends and is stimulated or retarded accordingly. For 1956 Winger foresaw a normal increase of about 4.3 percent in the total demand for all oils, and a gain of over 400,000 barrels per day in the required new supply of petroleum, to be divided between domestic producers and importers.

N. B. Guyol, staff statistician, United Nations, New York, also on the program at the API meeting in San Francisco, foresaw further expansion of oil and gas markets in the next decade but at a lower rate than in the past, in discussing "Oil in the Total Energy Market."

Moderate Gains in 1956. Next year will be more a year of business change than one of growth, Hoadley predicted. "In 1956 we will see moderate growth," he forecast, "but much more change."

Prevalent emphasis on the word "growth" is proper, said Hoadley, "for our dynamic economy and most leading industries certainly are growing at impressive rates." However, he expressed some uneasiness about current talk of "terrific" growth ahead. "The danger is," he said, "that underlying growth is being taken for granted as literally underwriting the almost indefinite success of individual industries, markets, and products.

"In my opinion," Hoadley stated, "this simply is not true, and certainly if we have in mind continuation of anything like present products and present methods of manufacturing and distribution. There is reason for concern if we allow ourselves to rely too heavily upon long run growth and neglect problems of short run stability."

Hoadley summarized his forecast for 1956 as follows:

"We will not be able to count as

much on general economic expansion to bolster sales and earnings over coming months as we've experienced recently. We'll be more on our own.

"We should not rely unduly upon long term growth to insure successful operations next year. Our principal—perhaps only—chance to keep our perspective in the coming year . . . will be to establish realistic product and market goals and lay careful plans to achieve them."

Oil Demand to Rise. Total demand for all oils, domestic plus export, will average about 9,125,000 barrels per day in 1956, Winger forecast. That would be an increase of about 375,000 barrels or 4.3 percent over the demand of approximately 8,750,000 barrels daily expected for 1955. The indicated 1955 demand will be about 642,000 barrels or 7.9 percent greater than that of 8,108,000 barrels daily reported for 1954.

"If past trends continue," Winger stated, "some enlargement of the year end level of inventories can be expected in 1956. This assumption indicates that the rate of new supply to be required next year may approach 9,190,000 barrels per day." Winger said he did not know how this volume of supply would be divided between domestic production and imports. "But domestic producers and importers should have a substantial increment of more than 400,000 barrels per day to share between them."

The estimated 9,190,000 barrels per day of new supply in 1956 would be about 415,000 barrels or 4.7 percent above 1955. The approximately 8,775,000 barrels daily of new supply in 1955 was about 700,000 barrels or 8.6 percent more than the 1954 new supply of 8,079,000 barrels daily.

Turning to the outlook for refinery operations, Winger foresaw increased activity. "On the basis of individual product demand expected next year," he said, "we think refinery runs will need to average about 7,865,000 barrels per day."

Winger said that the economists of the Chase Manhattan Bank had made studies of the general economic situation and outlook and had reached conclusions similar to those expressed by Hoadley. "We see nothing in the business picture next year," he stated, "which would materially alter the normal growth trend of petroleum use."

He and his associates now give important consideration to general business trends in forecasting demand for petroleum products, Winger revealed. They believe petroleum use is becoming increasingly sensitive to over-all economic conditions, because oil is supplying a steadily growing proportion of the nation's energy requirements. In the past, he stated, they apparently did not give sufficient weight to general economic trends in oil market forecasting. The bank's forecast for 1954 foresaw a downturn in business but under-estimated the impact on petroleum use, said Winger. "We determined to do better for 1955," he continued. "But this time we failed to anticipate the vigor of the economic recovery, and consequently oil demand this year will exceed original estimates."

The necessity of giving careful attention to general business conditions in forecasting oil consumption has developed, according to Winger, in spite of the fact that some important uses of oil are relatively independent of business in general. Moderate business adjustments probably do not have measurable impact on the volume of oil consumed for heating, he explained. And conditions must deteriorate sharply before Americans consciously curtail use of automobiles.

Concerning the long range outlook of the petroleum industry, Winger was optimistic. "Our studies thus far," he disclosed, "have indicated oil demand in 1965 ranging from 13 million to 14.5 million barrels per day."

Long Range Outlook. Along with some slowing down of the petroleum industry's over-all rate of growth, Guyol predicted different rates of increase in demand for different products of the industry.

The very high rates of development of the oil and gas markets during recent years have been made possible, Guyol explained, "by the expansion of the U. S. economy and the displacement of other sources of energy from their actual or potential markets. In the coming decade, he continued, the rates of development in oil and gas sales may be expected to decline until they reach about the same level as rates of growth in useful requirements of all energy. This rate is 4 to 5 percent per year, he said.

In the case of clean oils—including everything from gasolines through distillate fuel oils—an early decline from the recent high expansion rate is in prospect, Guyol predicted. There is some possibility that these oils will be displaced to some extent by natural gas, he added.

"I would expect the market for these oils, which has been developing at the rate of 7 percent per annum, to develop at a rate of no more than 5 percent per annum after 1960," said Guyol, "with the rate beginning to fall within the next three years."

He added that he expects a shift away from the lighter distillates, especially the gasolines, and toward the middle distillates.

The future market for residual fuel oil is unpredictable, according to Guyol. Portions of this market—such as the railways—have already been lost to other fuels, and further losses are in prospect, especially in the transport sector of the economy, he stated.

Two large potential markets exist for residual fuel oil. These are electric power plants and industrial establishments. They could absorb much more residual than the U. S. is likely to produce, Guyol stated. How much residual fuel oil they actually will use, however, will depend, he said, almost entirely on the price of residual in comparison with prices of competitive fuels, especially coal and natural gas.

Natural Gas Outlook Good. The natural gas market will continue to expand, according to Guyol, but at a rate somewhat below the 8½ percent at which it has been expanding in recent years. Substantially lower rates of expansion may be anticipated in the sales of gas to households and industry within the next few years, he said, for in those markets there is little room left for displacement of other sources of energy.

Use of gas in the generation of electric power will increase rapidly, at least until nuclear fuels become available at low cost and in large amounts, Guyol indicated. Unless significant changes occur in prices of natural gas relative to prices of other fuels, he predicted, there will be only a modest decline in the expansion rate of the natural gas market.

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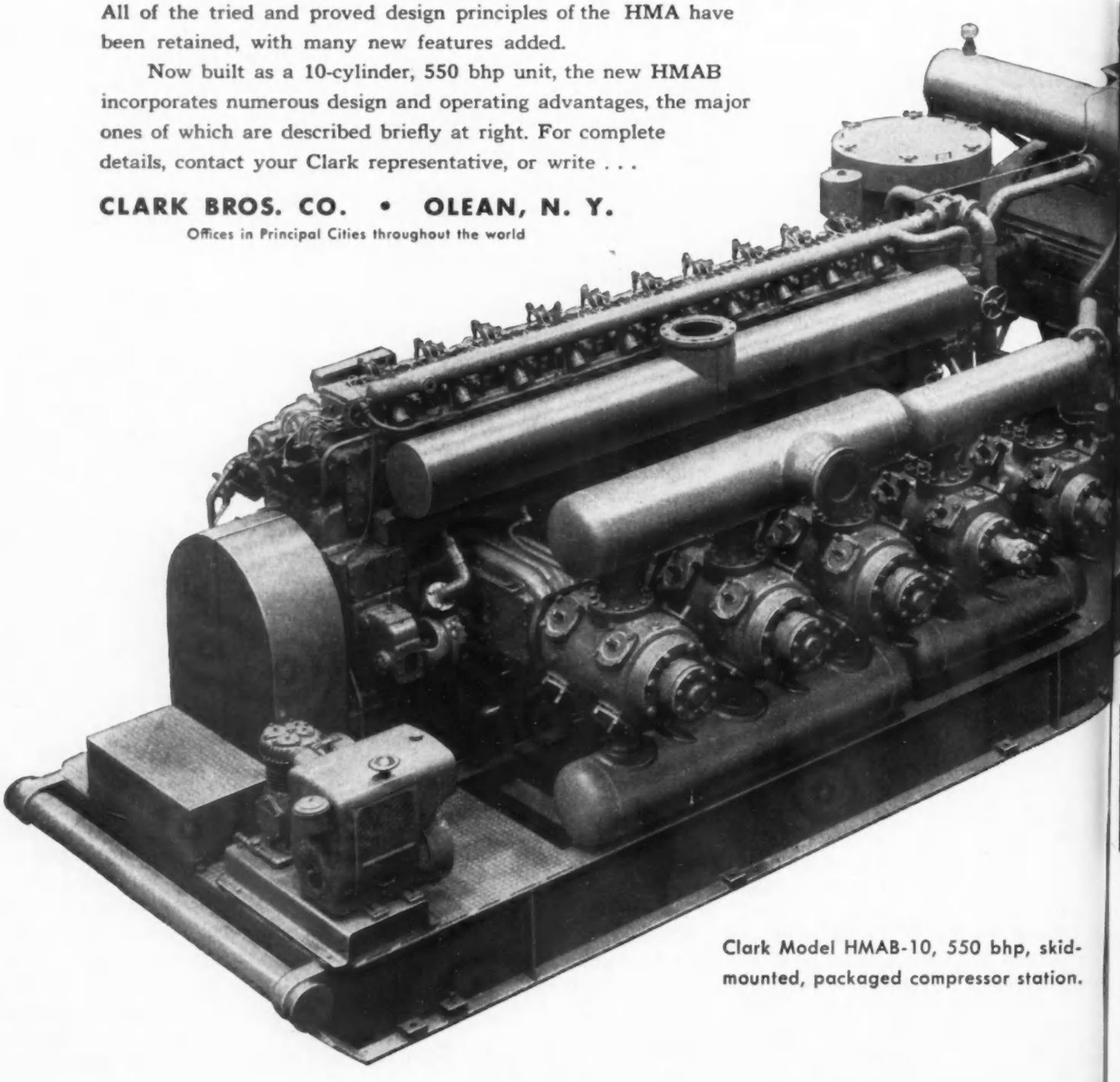

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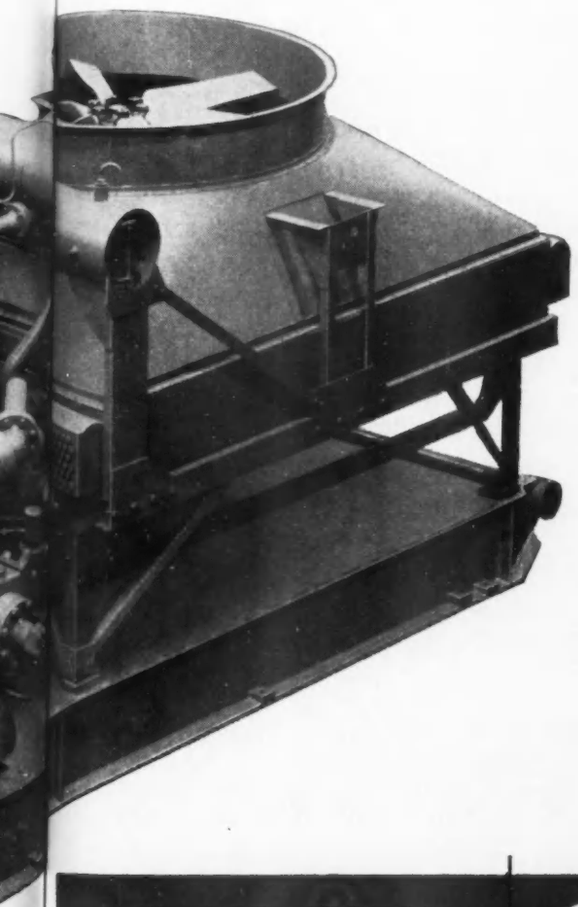

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REPORT FROM THE OBSERVATORY

By **RAY L. DUDLEY,** Publisher, and **WARREN L. BAKER,** Editor

Refiners Must Watch Output

HIGH OPERATING LEVELS during recent weeks did not help the economic position of the U. S. petroleum industry. Consequently, it has become increasingly important for the industry to watch its future operating levels with caution. Excessive operations will seriously damage the industry's economic condition during 1956.

Refining levels in recent weeks have been just short of peak volumes. This resulted in increased production of gasoline and distillate fuel oil. Gasoline stocks rose sharply, creating a threat that they may become excessive by the end of March. Heavy demand caused some improvement in distillate stocks, but they are still on the excessive side.

Crude production also rose sharply in recent weeks, as did imports. Low inventories prevented greater supply from becoming a worry. However, further increases in U. S. crude production and imports are to take place in coming weeks, and if this trend is continued over too long a period, it will reverse the now excellent supply position.

•

REFINERY RUNS during the first 18 days of November averaged over 7½ million barrels daily, highest monthly average during 1955, and up sharply from October and September levels. Consequently, the production of all major refined products rose.

However, gasoline was the only inventory to show an increase. The comparative position of motor fuel stocks with a year ago volumes showed a big change. Inventories of motor fuel totaled 153½ million barrels on November 18, up 6¼ million barrels from a year ago although in mid-October they had been at the same level as in the preceding year.

Continued large seasonal additions to gasoline stocks will occur until the end of March. The problem is to hold them to reasonable limits. It would be desirable that motor fuel inventories next March not be more than 5 percent above 1955 volumes. This means they should not reach a total of more than 195 million barrels by the end of March. Consequently, winter additions to gasoline storage should be held to around 40 million barrels during the next 4½ months. Additions to motor fuel inventories during this same period in the 1954-55 winter totaled 37 million barrels. Hence, it is desirable that the output of gasoline be held to volumes that will restrict additions to storage to rates which existed in the 1954-55 winter.

Cold weather boosted the demand for distillate fuel oil, and the first drafts of the winter occurred during early November in inventories of this product despite large refinery output. This resulted in some improvement in the distillate picture, but inventories are still far above year ago. Distillate stocks on November 18 totaled 148⅔ million barrels, compared with 152 million on November 4. Whereas distillate inventories in mid-October were 15½ million barrels higher than at the corresponding period in 1954, they now are only 13⅓ million barrels larger. However, additional large reductions must be made during the coming 4½ months to reduce distillate inventories to reasonable levels by next spring.

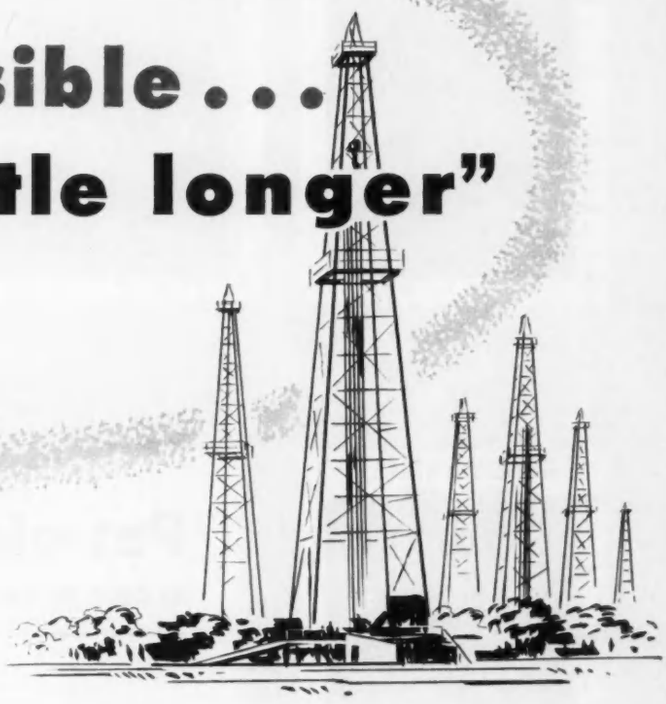
•

LARGE STOCKS of both gasoline and distillate fuel oil point out the need for refiners to exercise caution during the winter months. Unless refinery runs are held to reasonable volumes, stocks of both motor fuel and distillate oil could easily become excessive by next spring.

The situation is complicated further by uncertain weather conditions, which have a tremendous bearing on the quantity of distillate fuel consumed in the winter. Cold weather would take care of the surplus inventories of distillate, but warmer than normal weather would result in very excessive distillate stocks, particularly if refiners manufacture exceptionally large quantities.

How well refiners can tailor their output of motor fuel and distillate fuel to consumption during the next 4½ months will determine the industry's supply and demand picture during 1956. Therefore, it is extremely important that refinery output not be too much greater this winter.

"The impossible... takes a little longer"



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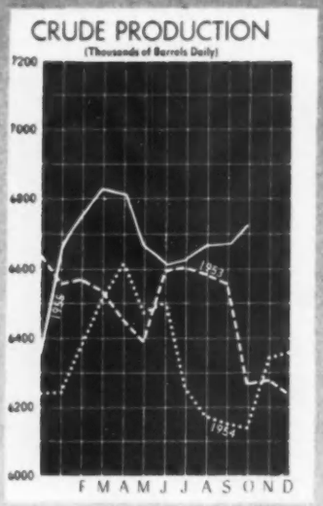
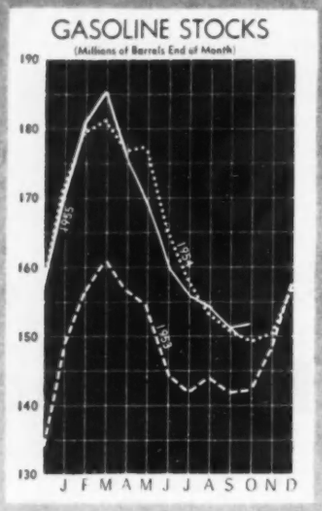
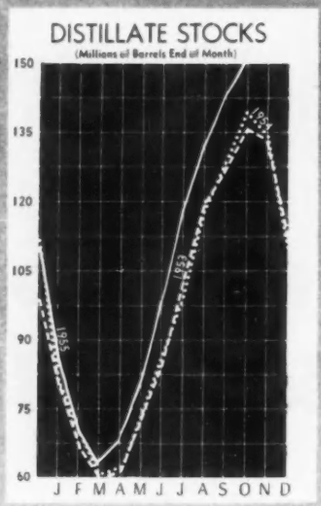
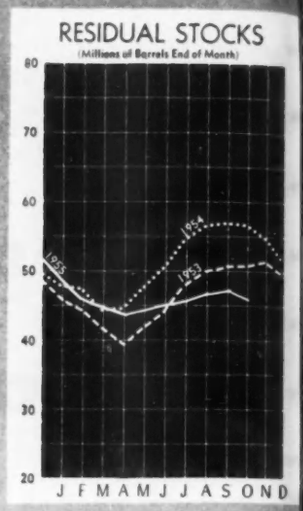
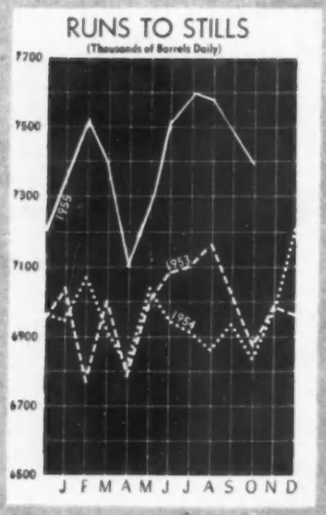
WILSON SUPPLY CO
HOUSTON, TEXAS

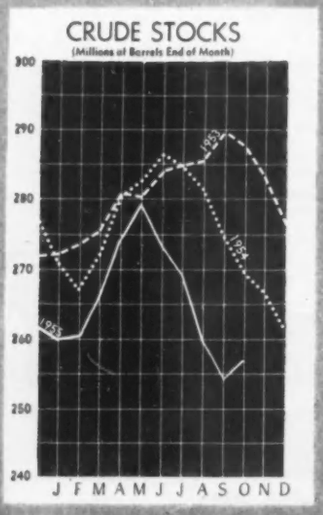












Petroleum Trends in U. S. . . .

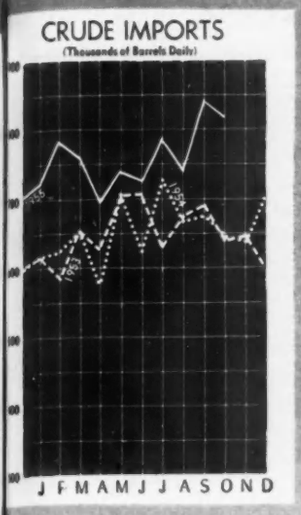
By CECIL W. SMITH, WORLD OIL Staff

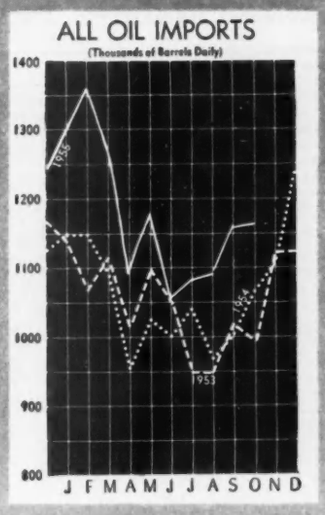
U. S. Crude Production by States

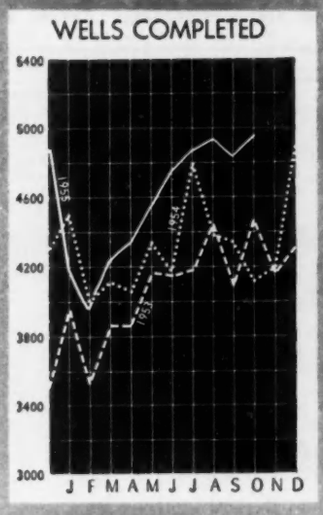
(THOUSANDS OF BARRELS)

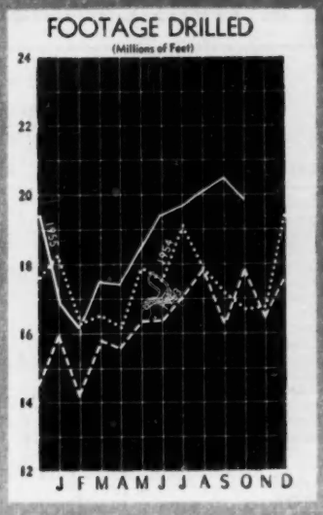
STATE or DISTRICT	DAILY AVERAGE PRODUCTION Oct., 1955	Sept., 1955	Oct., 1954	% Diff. Oct., '55-'54	TOTAL PRODUCTION First Ten Months 1955	1954	% Diff. '55-'54
Alabama	4.1	4.1	4.2	— 2.4	1,141	1,332	— 14.3
Arkansas	73.6	74.2	76.4	— 2.9	23,516	24,418	— 3.7
California	975.5	982.7	958.7	+ 2.5	295,877	297,293	— 0.5
Colorado	151.0	150.7	116.5	+ 29.4	41,724	33,552	+ 24.4
Florida	1.4	1.4	1.5	— 6.7	409	462	— 11.5
Illinois	231.7	236.1	194.6	+ 21.3	68,088	54,786	+ 75.7
Indiana	29.9	30.2	29.1	+ 3.8	9,184	9,337	— 1.6
Kansas	326.4	315.4	321.0	— 1.8	100,597	99,327	+ 1.2
Kentucky	42.7	44.0	38.9	+ 13.1	12,566	11,384	+ 10.4
Louisiana	753.9	741.9	627.4	+ 18.2	220,199	206,112	+ 6.8
North Louisiana	115.8	115.7	107.9	+ 7.2	35,901	34,191	+ 5.0
South Louisiana	638.1	626.2	519.5	+ 20.5	184,298	171,921	+ 7.2
Michigan	31.1	30.8	31.5	— 2.2	9,485	10,034	— 7.2
Mississippi	107.5	104.2	90.1	+ 15.6	30,296	27,928	+ 8.5
Missouri	0.2	0.2	0.1	+100.0	56	67	— 16.4
Montana	40.8	42.1	37.3	+ 12.9	13,015	11,122	+ 17.0
Nebraska	28.6	28.8	21.5	+ 34.0	7,790	6,080	+ 28.1
Nevada	0.1	0.1	.....	.....	52	20	+ 70.0
New Mexico	226.4	228.6	207.6	+ 10.1	67,851	61,928	+ 9.6
Southeast New Mexico	225.0	227.1	205.4	+ 10.6	67,073	61,307	+ 9.4
Northwest New Mexico	1.4	1.5	2.2	— 31.8	778	621	+ 25.3
New York	10.4	10.6	8.4	+ 26.2	2,608	2,728	— 4.4
North Dakota	20.5	33.8	19.1	+ 77.0	8,744	4,523	+ 93.3
Ohio	12.7	12.4	10.5	+ 18.1	3,577	3,161	+ 13.2
Oklahoma	543.7	537.0	479.5	+ 12.0	166,353	156,181	+ 6.5
Pennsylvania	22.0	22.2	22.7	— 2.2	6,973	7,728	— 9.8
South Dakota	0.1	0.1	0.1	.....	26	26	.....
Tennessee	0.1	.....	0.1	.....	14	14	.....
Texas	2,815.0	2,745.6	2,578.8	+ 6.5	870,369	816,497	+ 6.6
Dist. 1—South Central	50.6	50.0	42.8	+ 16.8	15,445	12,783	+ 20.8
Dist. 2—Middle Gulf	152.0	145.0	137.5	+ 5.5	45,634	43,420	+ 5.1
Dist. 3—Upper Gulf	431.9	427.6	420.3	+ 1.7	137,180	133,477	+ 2.8
Dist. 4—Lower Gulf-S.W.	241.9	236.4	231.6	+ 2.1	74,077	74,173	— 0.1
Dist. 5—East Central	51.2	50.0	43.0	+ 16.3	14,737	13,483	+ 9.3
Dist. 6—Northeast	340.9	123.8	315.9	— 60.8	104,659	103,680	+ 0.9
Dist. 7-B—North Central	149.1	145.8	133.8	+ 9.0	43,261	38,668	+ 11.9
Dist. 7-C—West Central	169.3	169.9	175.5	— 3.2	55,519	54,799	+ 1.3
Dist. 8—West	932.2	904.0	823.7	+ 9.7	284,041	258,730	+ 9.8
Dist. 9—North	205.9	196.2	188.4	+ 4.1	60,449	56,747	+ 6.5
Dist. 10—Panhandle	90.2	90.2	86.8	+ 3.9	26,825	25,167	+ 6.6
Utah	6.3	6.6	4.9	+ 34.7	1,782	1,566	+ 13.8
Virginia	0.1	0.1	.....	.....	14	8	+ 75.0
West Virginia	6.4	6.4	7.4	— 13.5	1,963	2,450	— 19.9
Wyoming	270.0	277.4	247.5	+ 12.1	83,062	77,679	+ 6.9
Total United States	6,732.2	6,667.6	6,342.9	+ 5.1	2,047,331	1,927,743	+ 6.2

Source: Bureau of Mines and API. Texas districts data from API and do not necessarily agree with State totals.









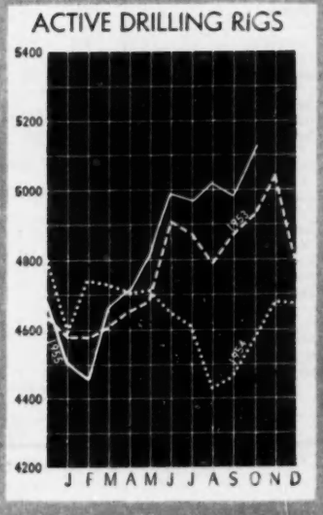
- **New wells at all-time monthly peak**
- **Active rigs highest since mid-1952**
- **Oil imports continue slow growth**

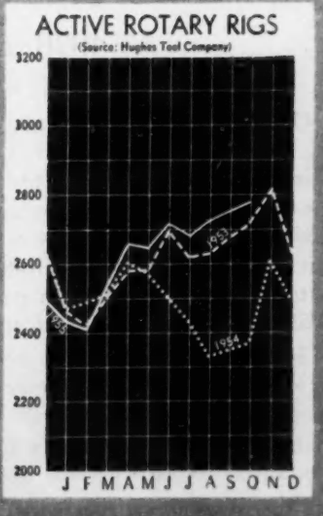
Crude Oil and Refined Products Trends

(THOUSANDS OF BARRELS)

MONTH	CRUDE OIL			GASOLINE		DISTILLATE FUEL		RESIDUAL FUEL		DAILY IMPORTS	
	Production Daily	Runs to Stills Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Crude Oil	Total Oils
1953:											
July	6,603	7,103	284,976	3,583	143,916	1,441	102,394	1,224	47,966	629	946
August	6,583	7,163	285,352	3,592	146,050	1,437	119,542	1,222	50,007	672	946
September	6,557	7,023	289,614	3,521	144,184	1,448	126,709	1,203	50,516	692	1,013
October	6,262	6,872	287,541	3,437	144,495	1,462	135,409	1,184	50,820	639	990
November	6,277	6,987	283,021	3,528	150,747	1,463	133,381	1,223	51,267	648	1,120
December	6,238	6,964	276,676	3,628	159,949	1,441	111,944	1,247	49,370	598	1,121
1954:											
January	6,240	6,947	270,811	3,431	171,704	1,550	81,044	1,271	47,474	617	1,143
February	6,379	7,068	266,918	3,476	179,950	1,545	70,390	1,241	47,119	621	1,144
March	6,507	6,923	271,867	3,375	181,297	1,458	60,270	1,168	44,249	654	1,088
April	6,615	6,811	280,310	3,404	177,006	1,374	61,721	1,140	44,362	574	950
May	6,471	7,038	282,250	3,482	177,606	1,372	73,581	1,148	47,009	708	1,021
June	6,500	6,947	285,155	3,483	165,404	1,399	86,325	1,123	50,216	624	999
July	6,242	6,916	284,894	3,480	158,010	1,416	101,657	1,089	54,365	724	1,038
August	6,168	6,862	281,043	3,492	153,168	1,453	117,579	1,069	56,322	664	966
September	6,151	6,939	274,608	3,511	150,916	1,514	128,061	1,086	56,702	672	999
October	6,135	6,834	269,442	3,457	149,661	1,545	139,128	1,066	56,541	642	1,065
November	6,346	6,975	264,566	3,530	150,604	1,622	133,886	1,120	54,891	636	1,104
December	6,394	7,238	258,385	3,605	155,400	1,668	108,144	1,187	52,105	729	1,301
1955:											
January	6,761	7,379	260,156	3,639	169,562	1,740	86,692	1,235	49,457	739	1,348
February	6,835	7,549	258,630	3,655	181,643	1,847	68,513	1,239	46,042	751	1,379
March	6,886	7,374	264,430	3,543	183,972	1,703	62,457	1,185	44,970	742	1,319
April	6,887	7,136	275,232	3,502	175,601	1,534	70,139	1,110	43,838	697	1,123
May	6,677	7,281	276,948	3,605	168,751	1,519	83,559	1,111	45,083	742	1,137
June	6,613	7,484	270,850	3,725	157,439	1,628	100,652	1,080	44,398	764	1,159
July	6,632	7,580	264,601	3,824	157,079	1,575	119,169	1,091	44,894	860	1,161
August	6,665	7,580	256,427	3,858	151,912	1,621	133,675	1,090	45,480	756	1,155
September	6,668	7,484	254,775	3,683	151,266	1,611	143,722	1,088	46,754	846	1,162
October	6,732	7,393	257,277	3,723	151,777	1,563	151,747	1,108	46,142	820	1,169
Oct., 1955 Change:											
In Month	+63	−91	+2,502	+40	+511	−48	+8,025	+20	−612	−26	+7
In Year	+597	+559	−12,165	+266	+2,116	+18	+12,619	+42	−10,399	+178	+104
Week Ended:											
11-11-55	6,808	7,553	257,839	3,688	152,084	1,585	150,606	1,118	45,761	721	1,132
11-12-54	6,220	6,883	267,049	3,453	147,896	1,630	136,159	1,122	56,068	623	1,036

Source: Data for last two months from API; prior monthly data from Bureau of Mines.





U. S. Wells Completed in October and First Ten Months, 1955-1954.

STATE or DISTRICT	NEW WELLS COMPLETED AND FOOTAGE DRILLED: DETAILS FOR OCTOBER: Oil	Dist.	Gas	Dry	Water Input	Gas Input	Water Disposal	TOTAL NEW WELLS: Oct., 1955	Sept., 1955	Oct., 1954	Total Footage October, 1955	DETAILS FOR JANUARY-OCTOBER: NEW WELLS: 1955	1954	Percent Diff.	FOOTAGE: 1955	1954	Rigs in Operation: Oct. 31, 1955	Sept. 30, 1955	Oct. 31, 1954
Alabama	1							1	1	5	11,517	36	62	— 41.9	157,395	330,279	9	6	7
Arizona												4	8	— 50.0	16,136	30,774		1	
Arkansas	42		1	31				74	81	50	229,156	650	490	+ 32.7	2,128,049	1,723,845	65	58	28
California	142		7	68	1			218	191	146	1,013,994	1,994	1,995	— 0.1	9,840,258	9,135,520	239	248	239
Colorado	36		11	100				147	144	118	787,793	1,282	1,074	+ 19.4	6,877,338	5,899,221	108	102	78
Florida									3	1		24	27	— 11.1	221,836	170,611	2	2	2
Georgia									1	1		1	8	— 87.5	4,130	20,508	2	2	
Idaho												3			11,337				
Illinois	190		3	185				378	366	330	932,159	3,186	2,638	+ 20.8	7,716,628	6,412,843	318	294	309
Indiana	23		1	25				49	63	78	92,296	517	715	— 27.7	809,475	1,048,737	91	105	118
Kansas	164		51	178				393	410	309	1,445,122	3,855	3,484	+ 10.6	14,717,256	12,352,281	480	456	414
Kentucky	79		15	77				171	150	114	220,773	1,376	1,144	+ 20.3	2,086,363	2,141,537	126	131	91
Louisiana	196	16	33	112				357	392	293	2,278,206	3,444	2,981	+ 15.5	22,223,348	18,558,414	378	381	297
North Louisiana	123	1	24	61				209	202	155	765,500	1,781	1,578	+ 12.9	5,550,146	4,676,782	86	90	68
South Louisiana	73	15	9	51				148	190	138	1,513,006	1,663	1,403	— 81.5	16,673,202	13,881,632	292	291	229
* Gulf of Mexico								30	44	16	278,463	277	192	+ 44.3	2,585,545	1,755,974	50	51	31
Maryland																	2	4	4
Michigan	22		1	28				51	55	52	156,543	443	465	— 4.7	1,317,169	1,258,633	85	84	103
Mississippi	11		3	25				39	40	42	220,819	379	352	+ 7.7	2,759,602	2,459,158	40	43	46
Missouri										2		24	11	+ 28.2	13,095	11,798	3	3	1
Montana	15	2		20				37	42	22	186,016	292	281	+ 3.9	1,438,923	1,111,025	50	52	41
Nebraska	24			65				89	96	42	485,908	709	367	+ 93.2	4,087,315	2,047,289	57	47	21
Nevada										1		6	11	— 45.5	44,828	56,156	1	1	3
New Mexico	82		56	27				165	173	86	698,959	1,433	985	+ 45.5	6,111,007	5,242,367	157	165	111
New York	23				14			37	34	21	50,761	303	472	— 35.8	418,057	687,403	51	49	57
North Dakota	18			10				28	29	28	207,971	217	238	— 8.8	1,524,162	1,658,646	22	29	22
Ohio	63		17	33				113	105	119	220,988	992	893	+ 11.1	2,067,179	1,739,143	218	213	193
Oklahoma	446	3	28	193	12		8	690	661	611	2,347,567	6,400	6,605	— 3.1	22,132,060	22,519,965	669	626	711
Oregon												1			7,101			1	1
Pennsylvania	18		21	6	14	5		64	66	59	126,046	614	809	— 24.1	1,165,369	1,484,880	132	125	132
South Dakota									2	1	8,685	12	17	— 29.4	52,476	92,827	1	2	1
Texas	989	29	42	610	4			1,674	1,611	1,417	7,421,747	16,256	15,224	+ 6.8	71,480,155	68,309,220	1,457	1,426	1,261
Dist. 1: South Central	99		2	78				179	146	86	487,660	1,484	928	+ 59.9	3,927,487	3,093,314	61	58	45
Dist. 2: Middle Gulf	40	4	9	22				75	57	66	474,675	676	683	— 1.0	4,041,746	4,167,595	45	41	49
Dist. 3: Upper Gulf	63	20	4	79				166	141	133	1,128,050	1,494	1,453	+ 2.8	9,623,905	9,716,677	145	147	125
* Gulf of Mexico								3	10		27,210	13			126,392		3	4	2
Dist. 4: Lower Gulf-S.W.	43	5	6	51	2			107	104	111	558,498	1,124	1,200	— 6.3	5,944,610	6,253,945	94	78	70
* Gulf of Mexico									12	1		12	2	+ 10.0	115,549	19,281	3	2	3
Dist. 5: East Central	5		1	14				20	17	14	82,849	217	227	— 4.4	846,620	866,995	14	21	19
Dist. 6: Northeast	32		7	24				63	73	61	344,049	599	605	— 1.0	3,192,983	3,542,094	64	60	61
Dist. 7-B: North Central	125		3	125				253	218	237	885,624	2,562	2,450	+ 4.6	8,251,326	7,828,100	162	172	126
Dist. 7-C: West Central	56		2	33				91	70	88	417,159	978	1,080	— 9.5	5,295,695	5,633,898	110	119	118
Dist. 8: West	305		1	53	1			360	304	190	1,898,542	3,206	2,384	+ 34.5	17,456,992	14,176,293	420	392	329
Dist. 9: North	162		1	121	1			285	388	368	883,967	3,101	3,403	— 8.9	10,012,674	10,327,730	249	246	254
Dist. 10: Panhandle	59		6	10				75	93	63	260,674	815	811	+ 0.5	2,886,117	2,702,579	93	92	65
Utah	1		1					2	16	9	11,456	81	56	+ 44.6	363,071	264,223	29	27	25
Washington																			1
West Virginia	5		47	9				61	68	54	177,889	538	468	+ 15.0	1,427,279	1,359,865	198	191	175
Wyoming	57		10	62				129	67	96	570,128	672	975	— 31.1	3,310,496	5,148,303	134	113	89
Total United States	2,647	50	348	1,867	45	5	8	4,970	4,867	4,107	19,902,799	45,744	42,855	+ 6.7	186,528,893	173,311,471	5,124	4,987	4,581
Total Western Canada	100		3	48			10	151	1,982	206	654,062	2,133	1,744	+ 22.3	9,162,255	6,857,443	219	225	142

* Gulf of Mexico wells are included on their respective district totals.

October Sets a Record

4970 new wells a peak for one month.

OCTOBER WAS the most active drilling month in the oil industry's history. More wells were completed during the month than in any previous period. A total of 4970 new wells was put into the records as complete, and it topped by 31 wells the previous peak reached in August of this year.

These wells boosted the year's total to 45,744, which was 6.7 percent more than last year's ten-month total. A month earlier, this year's lead had amounted to 5.1 percent, and October's stepped-up drilling rate caused the rise.

Continued high drilling activity should prevail during the year's final two months, as the number of active drilling rigs at the end of October was at the highest level since May, 1952. Rigs numbered 5124 at the end of the month, which was a gain of 137 during the period, and 543 more than was counted at the end of October, 1954.

Despite the month's record-number of new wells, the total amount of footage represented in those wells was not a new record. Actually October's 19,902,799 feet drilled was topped in each of the two preceding months. However, the year's ten-months total of 186,528,893 feet still leads last year's by 7.6 percent, which is a greater margin than wells hold.

Texas, leading drilling state, has exceeded the total U. S. Record. Its wells totaling 16,256 this year led last year's 10-months total by 6.8 percent. However, the number two state, Oklahoma, has seen a decline in activity. This year's 6400 wells represent a drop of 3.1 percent from last year's.

Kansas continued to hold onto third place in the nation with a 10-months total of 3855 wells, which was good for an increase of 10.6 percent over its 1954 performance. Louisiana has seen an even greater gain, and its wells numbered 3444 to top last year's by 15.5 percent.

California's wells this year have shown no change from 1954, there being only one well separating the two records.

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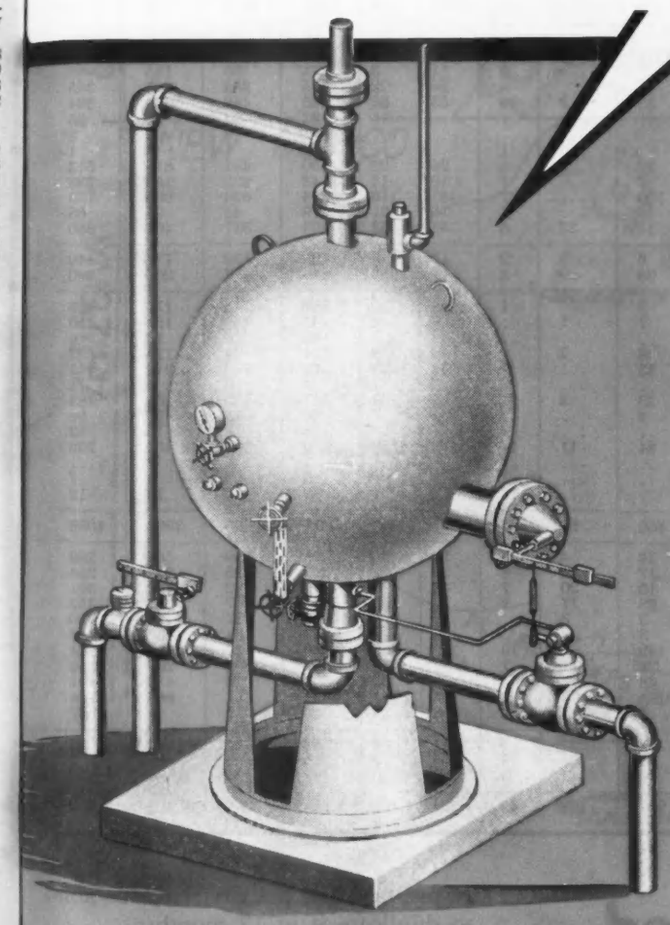

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FEATURES

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Wildcat Drilling—in October and First Ten Months, 1955-1954

STATE or DISTRICT	MONTH OF OCTOBER, 1955						FIRST TEN MONTHS, 1955-1954									
	New Fields			Total Discoveries	Dry Wildcats	Total Wildcat Tests	New Fields			Total Discoveries		Dry Wildcats		Total Wildcat Tests	
	Oil	Distillate	Gas				Oil	Distillate	Gas	10 Mo. 1955	10 Mo. 1954	10 Mo. 1955	10 Mo. 1954	10 Mo. 1955	10 Mo. 1954
Alabama	..	..	..	..	..	..	..	..	..	....	....	34	53	34	53
Arizona	..	..	..	..	..	..	..	..	..	....	....	4	8	4	8
Arkansas	..	..	..	..	12	12	9	..	2	11	3	114	86	125	89
California	1	..	1	2	38	40	16	..	4	20	22	275	283	295	305
Colorado	5	..	..	5	69	74	33	1	19	53	56	626	448	679	504
Florida	..	..	..	..	..	..	..	..	..	....	1	23	24	23	25
Georgia	..	..	..	..	..	..	..	..	..	....	....	1	8	1	8
Idaho	..	..	..	..	..	..	..	..	1	1	....	2	1	3	1
Illinois	5	..	1	6	75	81	22	..	3	25	22	590	491	615	513
Indiana	..	..	..	..	8	8	9	..	1	10	11	148	222	158	233
Kansas	12	..	2	14	99	113	130	..	31	161	116	804	623	965	739
Kentucky	..	..	..	..	11	11	13	..	2	15	21	79	44	94	65
Louisiana	1	4	2	7	52	59	31	22	5	58	63	409	317	467	380
North Louisiana	..	1	2	3	27	30	6	3	2	11	10	163	130	174	140
South Louisiana	1	3	..	4	25	29	25	19	3	47	53	246	187	293	240
Michigan	1	..	..	1	17	18	3	..	1	4	10	168	175	172	185
Mississippi	..	..	..	..	17	17	7	1	..	8	6	143	144	151	150
Missouri	..	..	..	..	..	..	..	..	..	....	....	17	6	17	6
Montana	..	2	..	2	14	16	8	2	..	10	8	114	84	124	92
Nebraska	1	..	..	1	41	42	33	..	1	34	28	279	115	313	143
Nevada	..	..	..	..	..	..	..	..	..	....	1	4	10	4	11
New Mexico	1	..	..	1	13	14	23	2	27	52	53	117	135	169	188
North Dakota	1	..	..	1	7	8	4	..	..	4	2	55	93	59	95
Ohio	..	..	..	..	..	..	..	..	1	1	....	15	12	16	12
Oklahoma	8	1	3	12	57	69	84	11	18	113	119	539	583	652	702
Oregon	..	..	..	..	..	..	..	..	..	....	....	1	....	1	....
Pennsylvania	..	..	..	..	..	..	..	..	1	1	....	2	1	3	1
South Dakota	..	..	..	..	3	3	..	..	..	....	1	12	11	12	12
Texas	39	7	3	49	351	400	456	69	52	577	583	3415	3453	3992	4036
Dist. 1: South Central	..	..	..	..	52	52	19	4	1	24	30	339	259	363	289
Dist. 2: Middle Gulf	3	2	1	6	15	21	17	14	8	39	29	207	225	246	254
Dist. 3: Upper Gulf	1	4	..	5	43	48	16	20	7	43	35	349	332	392	367
Dist. 4: Lower Gulf-S.W.	3	1	2	6	31	37	28	17	8	53	45	331	307	384	352
Dist. 5: East Central	..	..	..	..	12	12	3	3	..	6	3	115	117	121	120
Dist. 6: Northeast	..	..	..	..	16	16	3	3	..	6	8	151	134	157	142
Dist. 7-B: North Central	14	..	..	14	79	93	139	1	10	150	165	740	759	890	924
Dist. 7-C: West Central	5	..	..	5	22	27	38	..	7	45	55	222	301	267	356
Dist. 8: West	6	..	..	6	32	38	68	..	1	69	85	365	316	434	401
Dist. 9: North	7	..	..	7	46	53	123	2	8	133	113	536	651	669	764
Dist. 10: Panhandle	..	..	..	..	3	3	2	5	2	9	15	40	52	49	67
Utah	..	..	1	1	6	7	7	..	5	12	4	60	34	72	38
West Virginia	..	..	1	1	..	1	..	..	8	8	....	13	2	21	2
Wyoming	2	..	1	3	30	33	20	..	3	23	56	161	175	184	231
Total United States	77	14	15	106	920	1,026	908	108	185	1,201	1,186	8,224	7,641	9,425	8,827

Wildcatting Lead Boosted

October's volume pushes year's margin to 6.8%.

THE NATION's wildcatters continued to set new records during October, and the large number of tests completed boosted the year's activity to a 6.8 percent lead over last year's record operations. The number of wildcat wells drilled was the greatest ever recorded in the month of October.

A total of 1026 tests was finished during the month, which was only three less than September's wells, but it was 201 more than completions in October, 1954. However, the month's operations did not quite match September's in degree of success. October's tests resulted in the opening of 106 new oil, distillate, and gas fields for a 10.3 percent success rate. September's 119 new discoveries amounted to 11.6 percent of total tests completed.

The tremendous wildcatting effort this year has far overshadowed anything in the past. More tests have been drilled and more new sources of production have been uncovered. Last year had held the crown for wildcat drilling activity, but 1955 has topped that record in every department. Wildcat tests in 10 months totaled 9425 to best 1954's 8827 by 6.8 percent. Discoveries numbered 1201, and they exceeded last year's 1186 by 1.3 percent.

It has taken volume exploring to do it, but this year's 1201 new finds have never been equalled in 10 months. In fact, it was only 1954's record-breaking activity that was able to duplicate it in 12 months.

The large number of new fields opened so far this year has simply been the result of a vast number of wells drilled. Production was obtained in 12.7 percent of the tries, which figures to be a successful well out of almost every eight drilled. That is a little better than the historical average, but it does not quite match last year's 13.4 percent success rate, which was one new discovery for every 7½ wildcat attempts.

Summary of Results of Wildcat Drilling

ITEM	Oct., 1955	Sept., 1955	TEN-MONTHS January-October 1955	1954	Percent Diff.
New Field Discoveries:					
Oil	77	93	908	889	+ 2.1
Distillate	14	6	108	100	+ 8.0
Gas	15	20	185	197	— 6.1
Total Discoveries	106	119	1201	1186	+ 1.3
Dry Wildcats	920	910	8224	7641	+ 7.6
Total Wildcat Tests	1026	1029	9425	8827	+ 6.8
Percent Productive	10.3	11.6	12.7	13.4	.....
Percent Dry	89.7	88.4	87.3	86.6	.....

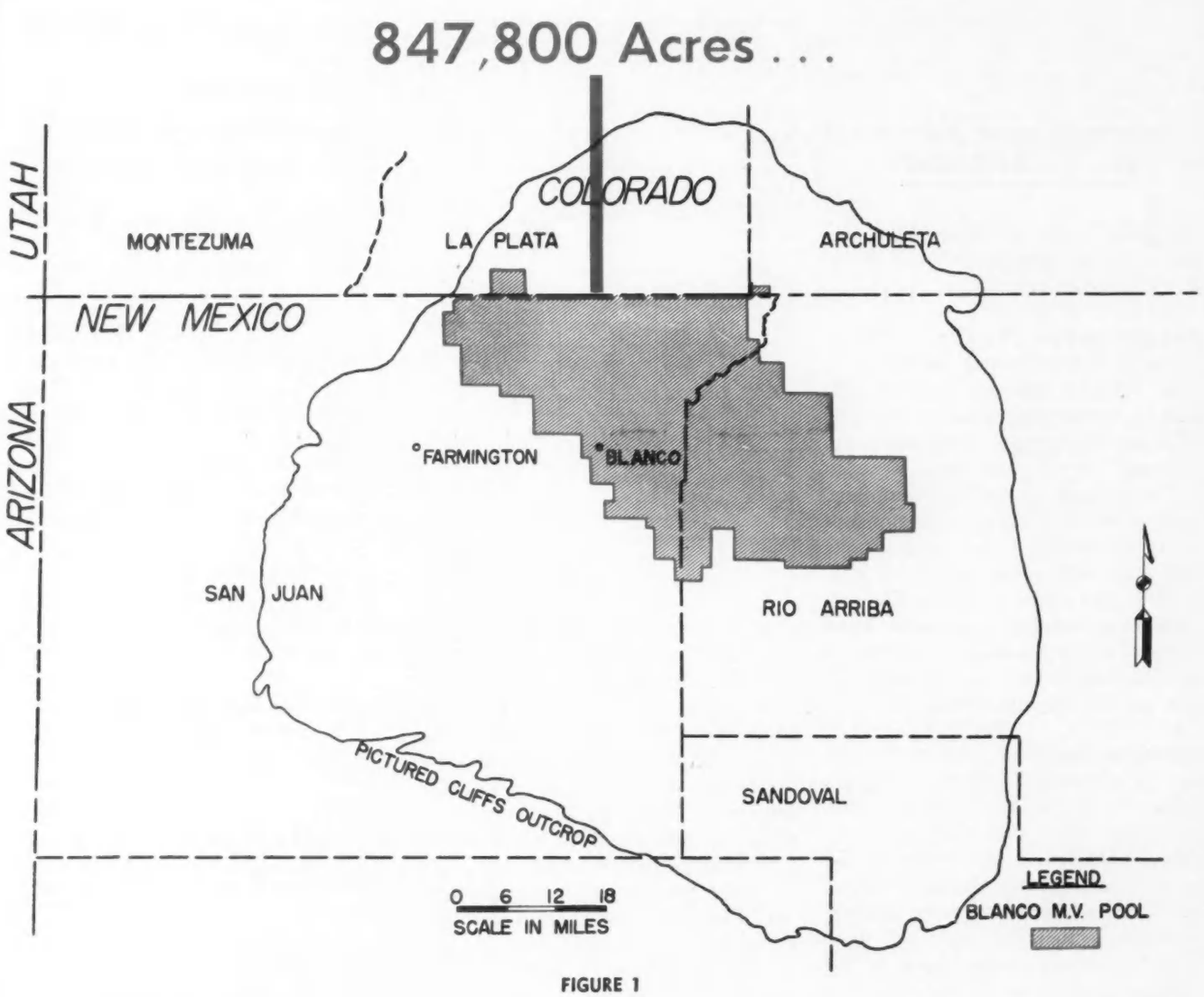

FIGURE 1

Blanco-Mesa Verde Gas Pool

One of the largest area fields in the world is discussed with special reference to drilling, completion practices and characteristics of the producing formation.

By R. W. ALLEN, JR.,
El Paso Natural Gas Company,
Farmington, New Mexico

THE BLANCO-MESA VERDE pool is one of the most interesting and commercially important gas pools in the Four Corners area. In areal extent it is the largest gas pool in the state of New Mexico and one of the largest in the U. S.

It is located in the San Juan Basin of northwestern New Mexico and southwestern Colorado. The nearest town, Blanco, N. M., from which the pool name is derived, lies on the southwest edge of the pool. (Figure 1)

The area of present production is 64 miles long, from northwest to southeast, and 34 miles wide. The area now considered as the pool limits contains an estimated 847,800 acres. Of this total, approximately 835,000 acres lie in the New Mexico portion of the pool. Figure 2 illustrates the outline of the pool limits to date. However, with the present rate of drilling and completion of wildcats,

"Average cost per well is . . . $80,000"

the pool limits as shown will undoubtedly be extended to the north, south, east and west.

Topography. The Blanco-Mesa Verde pool being a part of the Colorado Plateau province is characterized by broad table lands and rolling hills interrupted by steep cliffs and canyons.

The surface is, for the most part, broken and hilly. The rocks consist of many alternating layers of sandstone and shale. Altitudes range from 5500 to 8000 feet above sea level. The San Juan river flowing southward across the pool and the Animas river flowing southwestward meet at Farmington and provide the main drainage.

Stratigraphy. Since papers concerning the stratigraphy of the San Juan basin and of the Blanco-Mesa Verde pool have been published so extensively, it is felt that this section should be omitted from this article. For those not familiar with the area a bibliography is included covering those articles and papers pertaining to the type sections found in this area. Actual reservoir rocks are described in the discussion of the producing sands.

Structure. The structure of the Blanco-Mesa Verde pool is relatively simple. Being a portion of the San Juan basin, it is both a topographic and structural depression, and assumes the shape of a broad assymetrical syncline.

Figure 3 is a generalized contour map of the top of the Cliff House sandstone. The strike, as shown by the contours, is northwest. The dip on the southwest side is northeast 50 feet per mile and gradually flattens toward the northeastern side of the pool. The dip on the northeast edge is southwest and is approximately 60 feet per mile.

Drilling. The wells in the pool are drilled with rotary equipment from surface to total depth. The common drilling practice is to set approximately 150 feet of 9⅝-inch surface casing and to drill an 8¾-inch hole

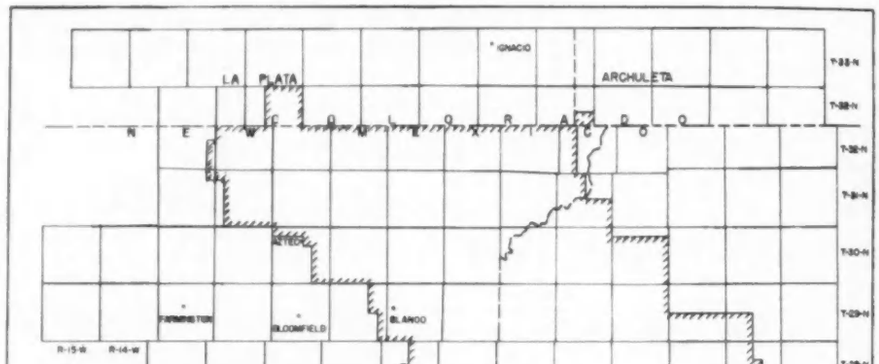

FIGURE 2—Outline of the pool limits to date.

to a point approximately 50 feet above the Cliff House sandstone where 7-inch casing is run.

In some areas the Cliff House is water bearing, and in such cases, the production string is set 50 to 150 feet above the top of the Point Lookout sandstone. The pay section is then drilled and completed as an open hole.

Ordinary drilling fluids are used until the production string has been run. From this point, until the total depth has been reached, natural gas is used as a circulating medium. This method of "drilling-in" has proved very satisfactory. W. T. Hollis (1954) compiled the following table on average data on wells drilled with natural gas:

TABLE 1

1. Gas Volume Used	2200 Mcf/D
2. Gas Pressure Used	400 psig
3. Length of Time to Drill the Average Footage of 782 ft. Well	4.6 days or 212 ft./day
4. Drilling Time:	
Upper Mesa Verde	4 min./ft.
Middle and Lower Mesa Verde	1 min./ft.
5. Footage Drilling per Bit	264 feet
6. Weight on Bits	12,000 lb.
7. Size of Bits	Mostly 6¾ inch
8. Maximum Footage Drilled with One Bit	891 feet
9. Rotary Speed	70 rpm
10. Maximum Size Hole Drilled	11 inches

The Mesa Verde has been successfully cored with gas using diamond core heads. A conventional type core head was used in the beginning but due to the abrasive action of the sand-carrying gas, a new type head was designed. This change simply amounted to the widening of the water courses and increasing the upset. Table 2 shows the average data on coring operations.

TABLE 2

1. Gas Volume Used	2200 Mcf/D
2. Gas Pressure Used	400 psig
3. Footage Cored	271 Feet
4. Coring Time	6 min./ft.
5. Core Heads Used per Well	1 to 3
6. Weight on Core Head	17,000 lbs.
7. Rotary Speed	40 rpm
8. Size of Core Head	6⅛ Inch
9. Recovery	85 Percent

The average cost per well, including road and location construction, casing, well head equipment and special services is $80,000.

Completion. Due to the low permeability and porosity of the pay section, natural gas flows are relatively small and many times non-commercial even with the low standards of the San Juan basin. In the past the pay section was shot with sometimes as much as 2400 quarts of solidified nitroglycerin. Gas flows were increased greatly but clean out time was an expensive problem. After the wells were cleaned out and completed, caving and sloughing was still a problem. The sand-oil method of fracturing is now used with better results both in the increase in gas volume and the decrease in clean out time.

What appears now to be the accepted method, by a great many operators, is drilling the Cliff House sandstone, setting a retainer in the 7-inch casing and sand-oil-fracturing. The hole is cleaned out by blowing it dry and then drilled to the base of

the Point Lookout sandstone. A drillable retainer is set 100 to 150 feet above the top of the sand and the section sand-oil-fractured.

The average treatment for each gas zone is 14,000 gallons of oil and 13,000 pounds of sand. Using this method of completion, the natural flows have been increased as much as 230 times with the average increase being 18 times.

Reservoir Conditions

Producing Sands. The sands of the Mesa Verde formation are lenticular over most of the pool. This feature is especially characteristic of the Menefee member. The Point Lookout and Cliff House sands are generally thought to be massive, single, sand bodies; but close inspection of the outcrops indicates that they consist of a number of relatively thick sands separated by shale breaks. This type of deposition, coupled with porosity and permeability changes within the individual sands, is thought to be the reason for the gas accumulation.

The major portion of gas being produced is from two sand bodies, the Cliff House and Point Lookout. These sands are found at average depths of 5000 feet and 5400 feet respectively. The Menefee member is capable of producing gas, but due to the small volume, it has not been considered in reserve calculations and will not be considered in this article.

The physical characteristics of the two productive sands are relatively uniform. They are light to medium gray, very fine grained, well cemented, and laminated with light to dark gray, carbonaceous shales. The average grain size is 0.10 mm. The sands are made up of approximately 50 percent quartz, 10 percent calcite and 30 percent montmorillonite. A study of cores from these two sands show the pores to be lined with as much as 75 percent montmorillonite. Figure 4 shows the combined net effective pay thickness of the Point Lookout and Cliff House sands. The greatest pay thickness is 160 feet and is found approximately in the middle of the pool.

Water Saturation. The connate water content varies from 70 percent to 10 percent. The average figure used in reserve calculations is 29 percent.

Water Encroachment. A water line has been established for the Cliff House sandstone on the southwestern

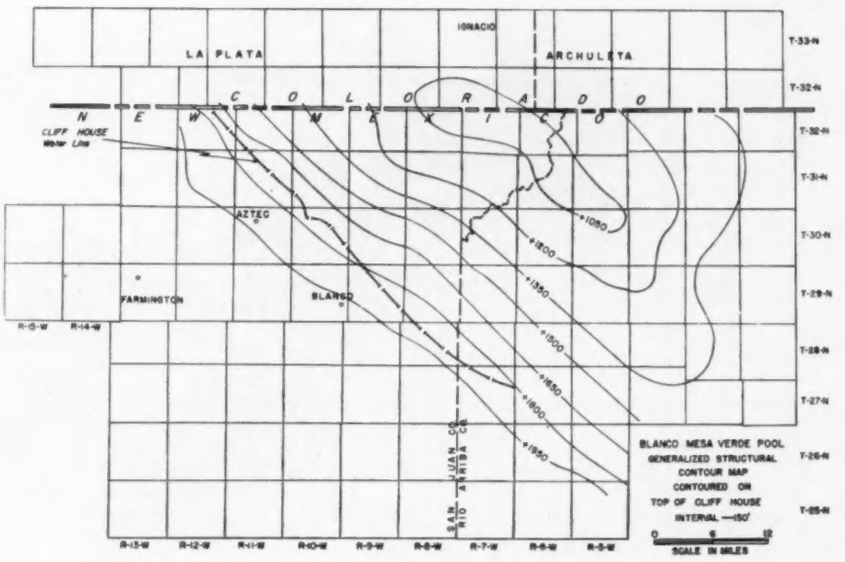

FIGURE 3

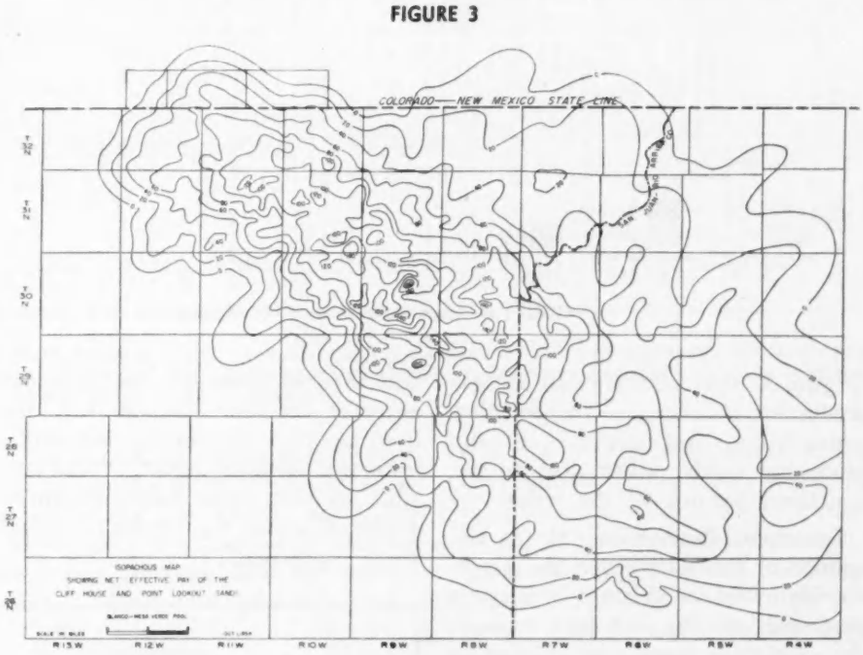

FIGURE 4

side of the pool. The water does not follow any one particular datum plane. (Figure 3) Any further encroachment will undoubtedly be very slow due to the high clay content and low permeability of the sand. A line of water encroachment exists in the Point Lookout but has not been determined by this writer.

Bottom-Hole Pressure. The original bottom-hole pressure of the Cliff House was 1350 pounds per square inch at a subsea datum of plus 1600 feet. The Point Lookout had an original bottom-hole pressure of 1370 pounds per square inch at a subsea datum of plus 1150 feet. Due to the inaccuracy of records on older wells and the insufficient data on the more recent wells it is impossible to state any pressure decline figures at this time.

Porosity and Permeability. Available core analyses on the producing sands indicate that an average porosity of 10 percent may be given for both sands. The porosity varies widely both laterally and vertically and is not predictable. Permeabilities are also variable and range from 8 to .01 millidarcies, with an average permeability of 1.5 millidarcies.

Production Characteristics

Well Potentials. The initial potentials in the pool range from 500 Mcf per day to 30,000 Mcf per day with an average potential of 3000 Mcf per day. The isopotential map of the pool

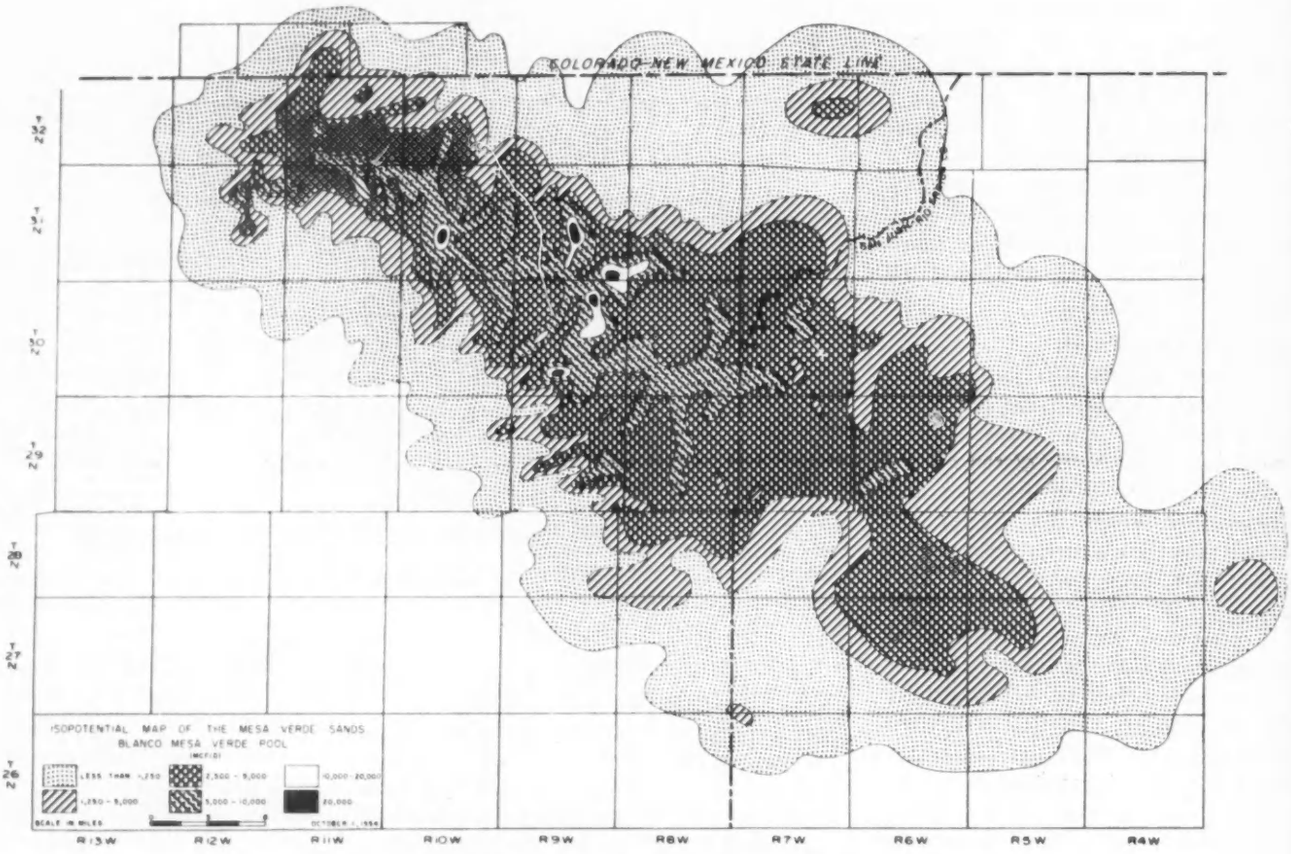

FIGURE 5—Isopotential map of the Mesa Verde sands Blanco-Mesa Verde pool.

(Figure 5) shows clearly that the gas production is related to the porosity, permeability, and thickness of the producing sands rather than to the structural position of the wells.

Interface Production. It is the opinion of this writer that the gas in the Blanco-Mesa Verde pool is being produced into the well bore through the sand-shale interfaces existing in the pay zones rather than directly from the sands. This opinion is based upon temperature surveys, magnetic susceptibility surveys and drilling information.

Due to the low permeability and porosity of the pay, an explanation was sought for the relatively large volumes being produced. Temperature surveys were run through the pay section and it became evident that the zones of maximum cooling, due to the gas expansion, occurred opposite the sand-shale contacts. To date more than 100 such logs have been run with 90 percent of them showing the gas to be coming from the interfaces.

With the advent of the sand-oil fracture method of completion a new logging tool which measures the magnetic susceptibility of the formation was used to determine the points of entry of the sand and oil. Injecting a compound containing magnetite, with the propping agent, it was possible to find these points of entry. Figure 6 shows the results of one of these experiments.

About the Author

ROY W. ALLEN, JR., chief geologist, San Juan Division, El Paso Natural Gas Company, received his B.S. degree in 1949 from Texas College of Mines and Metallurgy (now Texas Western College). He began geological work with El Paso Natural Gas Company in 1949 at Midland, Texas, and moved to the San Juan Basin in 1951.

In the process of drilling the Mesa Verde with gas it was noted that large increases in the natural gas flows occurred within very small intervals. The intervals, correlated with Gamma Ray-Neutron logs, proved to be sand-shale contacts. The majority of the Mesa Verde production has been found to come from the interfaces within the Point Lookout sand.

Well Spacing and Proration. In New Mexico the spacing of wells to be drilled to the Mesa Verde formation is limited to one per 320 acres. The locations are made in the northeast quarter or the southwest quarter of the section. The footage requirements, as set up by the New Mexico Conservation Commission read:

> ". . . and shall be located 990 feet from the outer boundary line of the tract provided however that a tolerance of 200 feet is permissible."

Due to terrain this footage requirement cannot always be met. In this case the location is classed as an unorthodox location and must be approved by the New Mexico Commission. In most instances the request for unorthodox locations due to inaccessible terrain is approved.

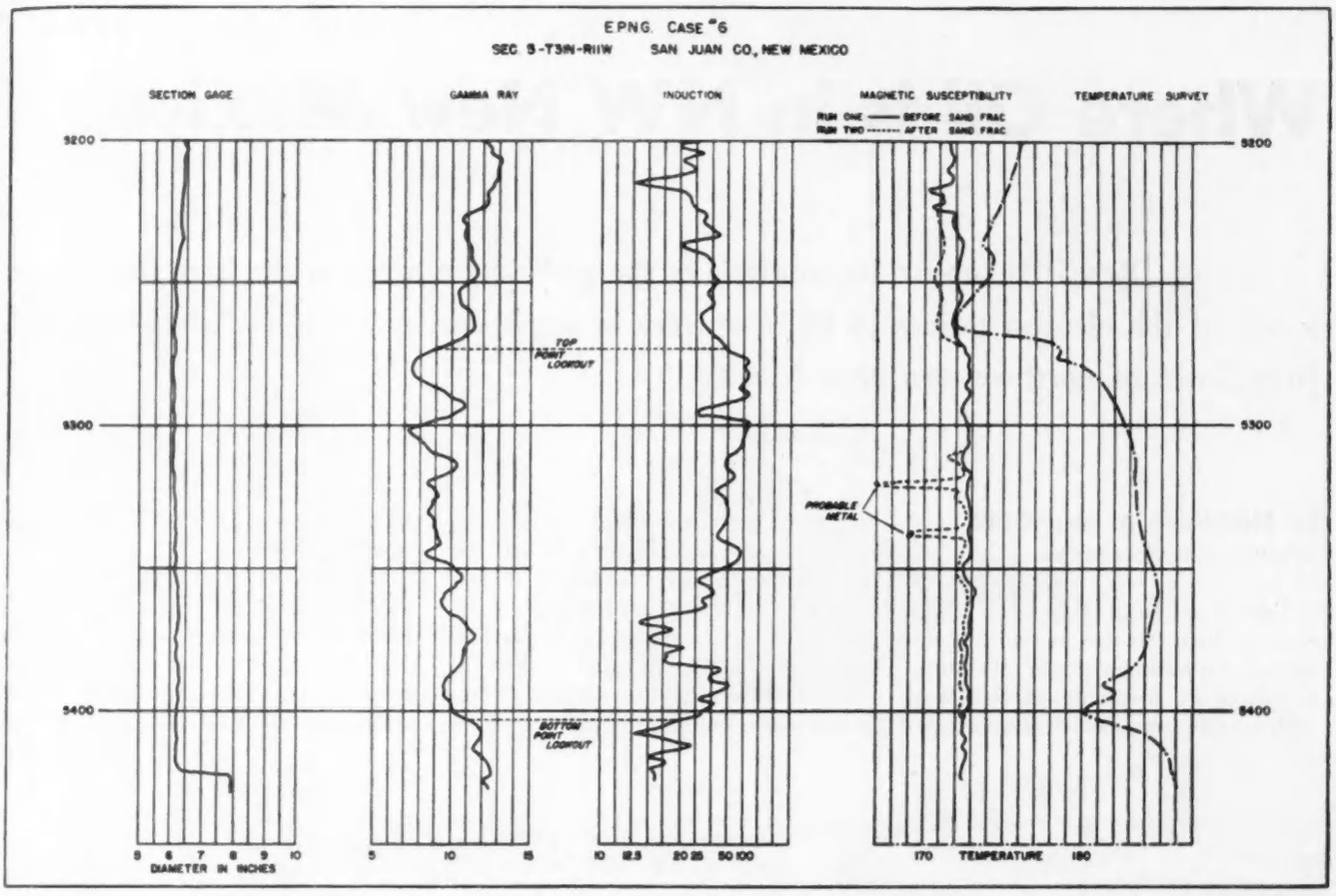

FIGURE 6—In using the sand-oil fracture method of completing a well, a new logging method, measuring the magnetic susceptibility of the pay formation, was used to determine the points of entry of the sand and oil. Injecting a compound containing magnetite, with the propping agent, it was possible to find these points of entry. The results are shown here.

The state of Colorado has no laws governing spacing or proration regarding the pool.

Production. The cumulative production from the Blanco-Mesa Verde Pool on January 1, 1953, was 102,888,160 Mcf. Production figures, both cumulative and annual, are presented in Table 3.

Reserves. Reserves are very difficult to estimate in a pool such as Blanco-Mesa Verde where porosity-permeability traps are involved, where interface type production exists, and where sufficient production and bottom hole pressure data are unavailable to calculate pressure decline curves.

During the early stages of development the ultimate recovery was estimated at three trillion cubic feet. The present figure is estimated to be 8 to 15 trillion cubic feet from 750,000 acres, which would be approximately 15 million cubic feet per acre. It is very probable that the pool's ultimate recovery will exceed these figures.

TABLE 3
Gas Production—Blanco-Mesa Verde Pool

YEAR	Production for Period (Mcf)	Cumulative Production (Mcf)
1929	.....	279,400
Figures not Available. Cumulative Production Approximate		
1940	.....	.....
1941	44,000	323,400
1942	46,000	369,400
1943	50,000	419,400
1944	58,000	477,400
1945	65,000	542,400
1946	67,320	609,720
1947	78,020	687,740
1948	75,890	763,630
1949	808,640	1,572,270
1950	787,910	2,360,180
*1951	10,387,530	12,747,710
1952	28,687,660	41,435,370
1953	61,452,790	102,888,160

* El Paso Natural Gas Company 24-inch Transmission Line to California began operations.

Future Developments. At the present rate of development the Blanco-Mesa Verde pool is fast becoming one of the largest gas producing pools in the Rocky Mountain area. With the possibility of an additional market in the form of Pacific Northwest Pipe Line Company's line to serve the Pacific Northwest an incentive has been given for accelerated development.

Future development of the pool will not only consist of the further development of producing leases but the drilling of wildcat wells. It might be noted here that of the producing leases only approximately one-half of this acreage has been drilled. Reserve figures and the pool limits will undoubtedly be greatly enlarged.

Indications are that the following few years will be the most active since the pool's discovery.

ACKNOWLEDGMENT

The writer expresses his appreciation to the management of the El Paso Natural Gas Company as well as to the Rocky Mountain Section, AAPG, for permission to publish this article. Also to C. J. Kahwajy who is responsible for the drafting and to the many friends who criticized the manuscript and helped in the preparation of this article.

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Where Oil Is in NW New Mexico

Research subsurface analysis of the productive areas in the San Juan Basin is one of the clearest guides to the discovery of important new oil reserves in the San Juan Basin of northwestern New Mexico.

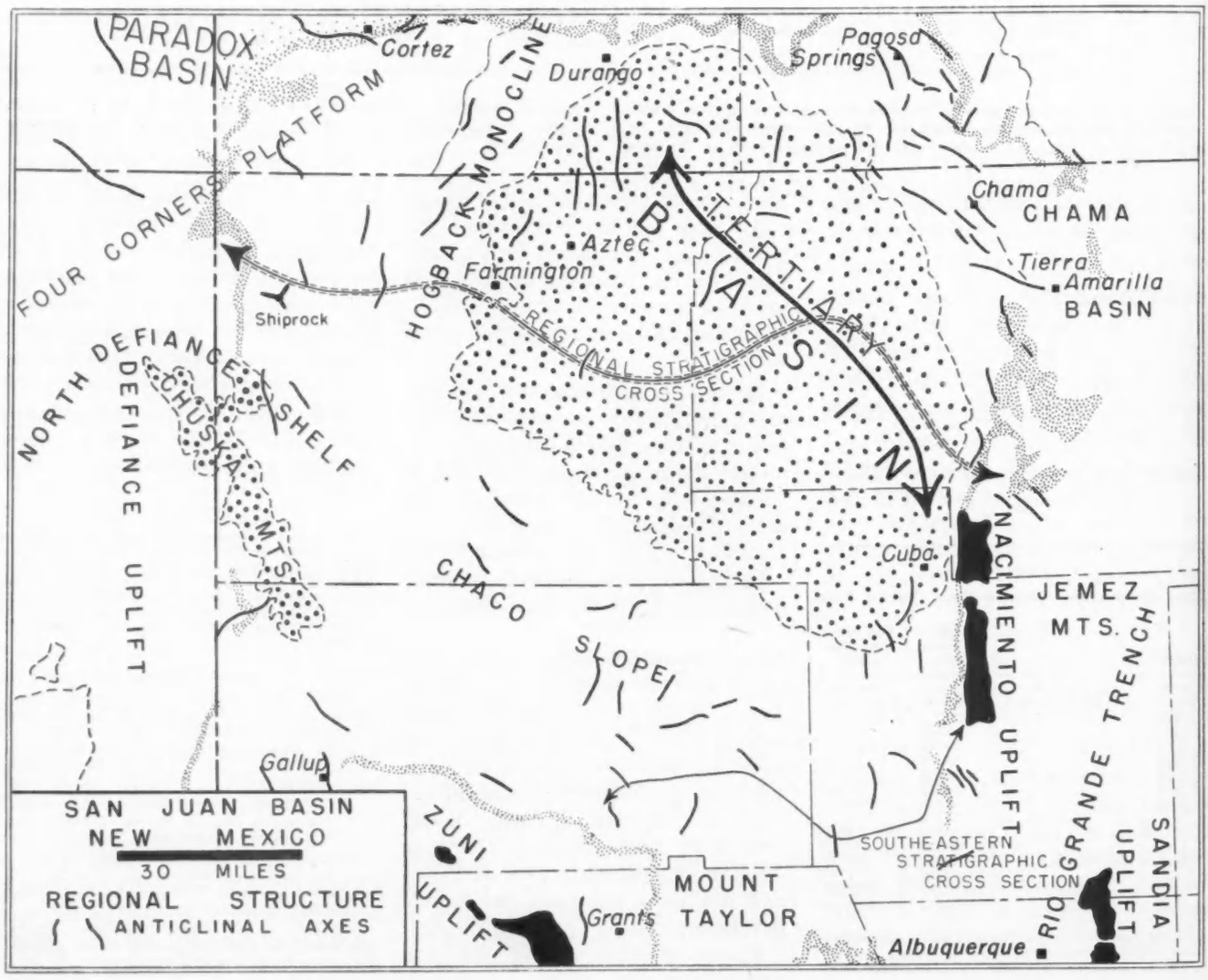
By SHERMAN A. WENGERD
Albuquerque, New Mexico

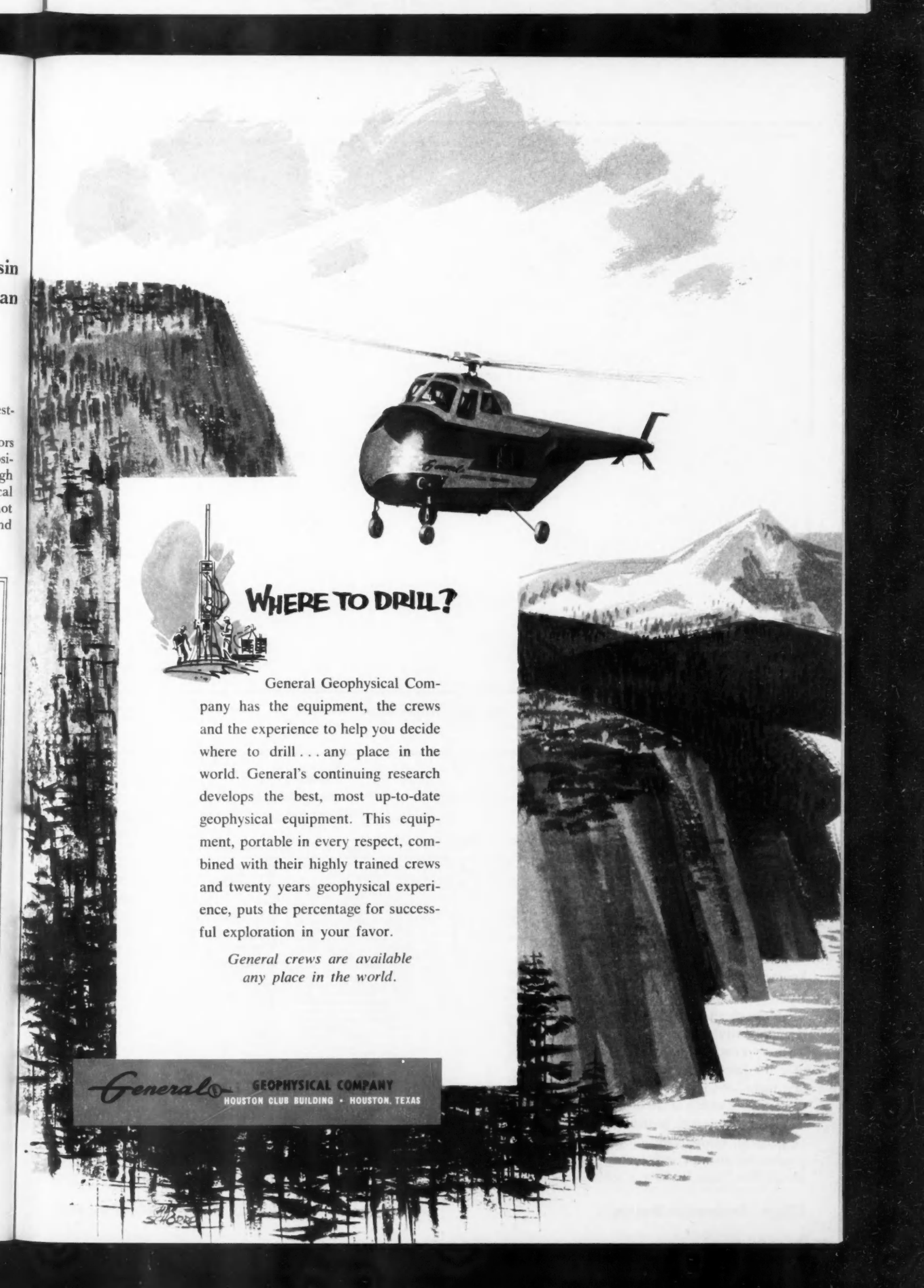
THE SAN JUAN BASIN of northwestern New Mexico is entering the critical exploratory phase of subsurface geology involving careful work with sample logs, electrical and radioactivity logs, seismic work, and compilations of engineering data on the fluid systems which control the migration, accumulation and retention of oil.

Two major systems, the Pennsylvanian carbonates at depths of 8000 to 13,000 feet, and the Upper Cretaceous clastics at 500 to 9000 feet, have the highest oil potential in northwestern New Mexico.

The tectonic and dynamic factors which resulted in differential subsidence of the San Juan Basin, although they may have caused certain critical shifts in oil accumulations, were not as important to the migration and

FIGURE 1

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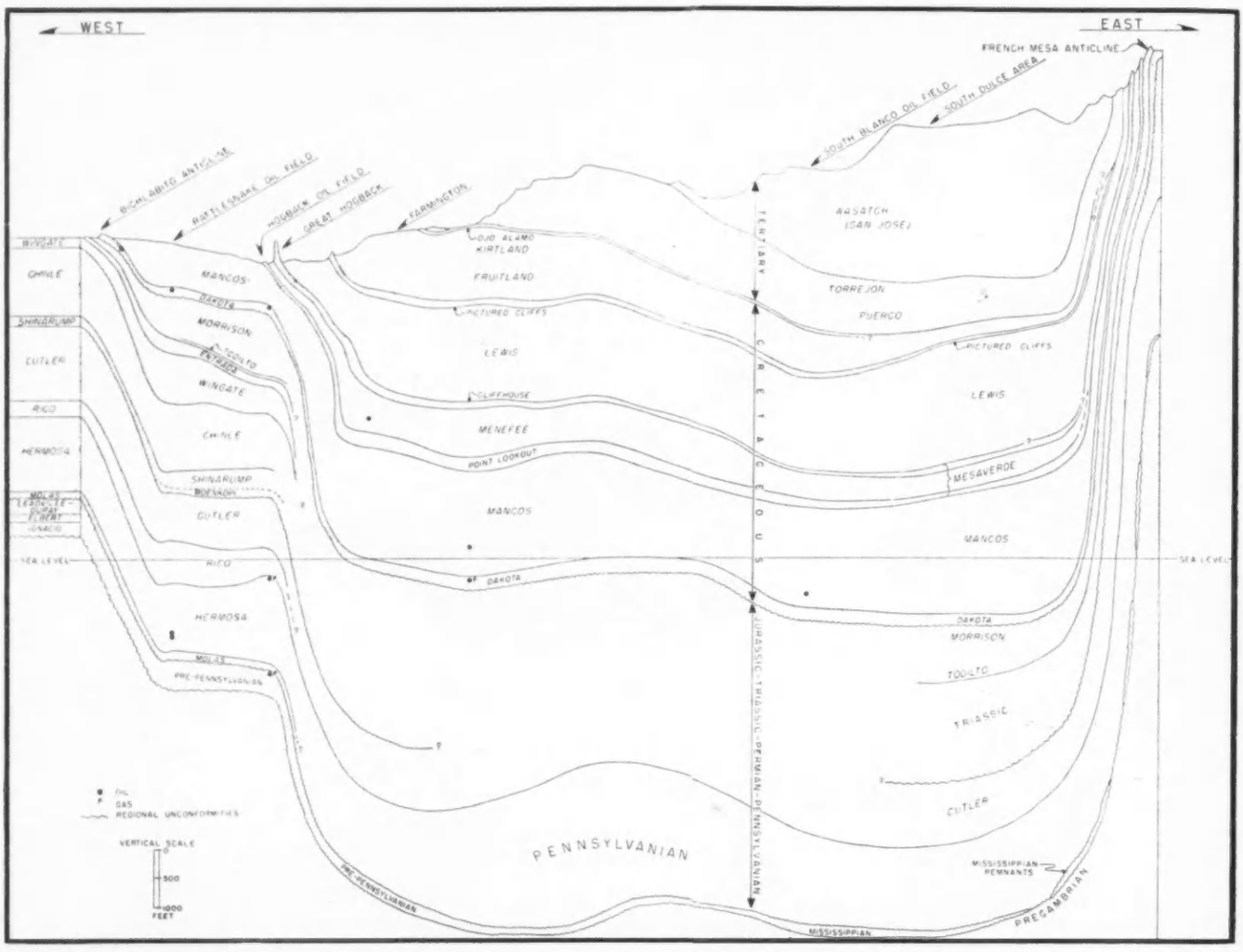

FIGURE 2—Regional stratigraphic cross section San Juan Basin. Vertical exaggeration 40 X. (See Figure 1 for trace of cross section).

accumulation of oil as the sedimentational factors in existence when these shelf sediments were being deposited, long before the San Juan Basin became a separate entity.

Geologic Setting. Northwestern New Mexico encompasses about 19,000 square miles of which the San Juan Basin comprises the major structural unit. This basin contains over 35,000 cubic miles of sedimentary rocks ranging from Cambrian to Eocene age within the rimming Dakota outcrop (Figure 1).

Thicknesses of sedimentary rock in the presently deepest part of the basin approach 15,000 feet, although only the latest Cretaceous and Tertiary rocks are related genetically to the basining which created this ovate, frontal-intermontane structural basin (Figure 2). Consequently, by far the greater volumes of sedimentary rock in the San Juan Basin are shelf de-

TABLE 1*

Oil Production—San Juan Basin

(Cumulative to January 1, 1955)

Twp. N	Rge. W	Pool	Producing Formation	Oil Production (Barrels)
17–18	8–9	Hospah	Mesaverde	3,314,327
20	9	Red Mountain	Mesaverde	21,329
25–26	6–7	Canyon Largo (gas)	Pictured Cliffs	302
27	5	Companero (gas)	Dakota	135
24	2	Lindrith	Dakota	13,346
26–27	6	S. Blanco (gas)	Dakota	6,711
26–27	5–9	S. Blanco (gas)	Pictured Cliffs	3,449
26	6	S. Blanco	Tocito	1,248,568
19	3	Torreon	Entrada	7,978
19	4	Torreon	Mesaverde	350
24	10	Angels Peak (gas)	Dakota	20,471
29	11	Aztec (gas)	Fruitland	28
25–26	8–9	Ballard (gas)	Pictured Cliffs	3,799
32	14	Barker-Creek	Paradox-Penn	46,317
26–32	3–13	Blanco (gas)	Mesaverde	420,954
29	16	Hogback	Dakota	3,061,688
29	16	Hogback	Penn	14,426
26–27	9	Huerfano (gas)	Dakota	8,227
29–30	11	Oswell	Farmington SS	33,428
29–30	19	Rattlesnake	Dakota	4,559,691
29–30	19	Rattlesnake	Penn	489,531
21–22	13–14	Stoney Butte	Dakota	5,607
27	17	Table Mesa	Dakota	1,007,743
29	14	Twin Mounds (gas)	Mesaverde	1,545
27–28	12	West Kutz (gas)	Dakota	2,416
26–29	10–13	West Kutz (gas)	Pictured Cliffs	6
30	12	Wyper	Farmington SS	6,852
29	11	Bloomfield	Farmington SS	35,054
27–30	9–13	Fulcher Kutz (gas)	Pictured Cliffs	1,400
			Total	14,335,678

* Courtesy of William B. Macey
New Mexico Oil Conservation Commission.

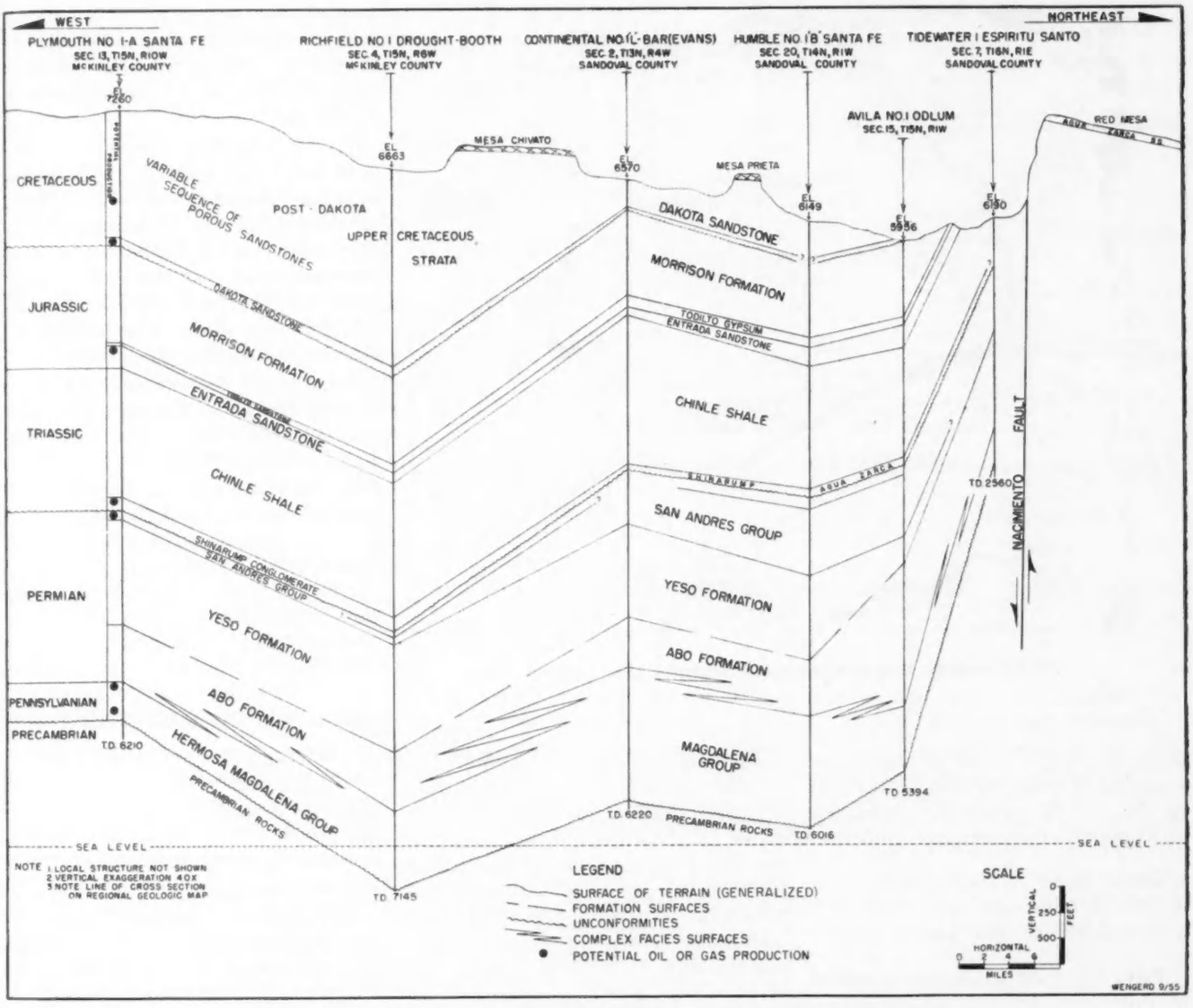

FIGURE 3—Stratigraphic cross section McKinley to Sandoval counties, New Mexico.

posits related to earlier, distant, geosynclines with very complex tectonic and sedimentational histories.

Oil Discovery. The total recorded volume of oil produced in northwestern New Mexico (San Juan Basin) to January 1, 1955, is 14,335,678 barrels (Table 1). This figure includes almost a half million barrels of very high gravity condensate-type oil produced with Pictured Cliffs, Mesaverde, and Dakota gas in the past four years. The record of oil exploration in the San Juan Basin extends from 1911 to the present with the two major periods of oil discovery being 1922-1935 and 1951-1955.

Considering the size, depth, geologic history and length of oil exploration of the San Juan Basin, the approximately 14½ million barrels of oil produced is indeed a small amount. Answers to the following questions

TABLE 2

1954 Oil & Gas Statistics (Northwest New Mexico)*

FIELDS	Gas (MCF)	Condensate (Barrels)	Oil (Barrels)
Angels Peak	229,599	5,980	.....
Aztex—Fruitland	34,208	28	.....
Barker—Pennsylvanian	10,469,882	15,001	.....
Blanco—Mesaverde	104,818,793	291,467	.....
Blanco—Pictured Cliffs	26,200	321	.....
Fulcher Kutz	8,457,630	441	.....
Hogback—Dakota	.....	.....	82,522
Hogback—Pennsylvanian	.....	.....	13,484
Hospah	.....	.....	88,205
Huerfano—Dakota	78,672	1,946	.....
Lindrith	2,376	.....	3,174
Rattlesnake—Dakota	9,755	.....	23,481
Red Mountain	.....	.....	1,457
South Blanco—Dakota	296,703	2,065	.....
South Blanco—Pictured Cliffs	8,012,208	3,418	.....
South Blanco—Tocito	38,986	.....	370,765
Table Mesa	.....	.....	11,363
Torreon—Entrada	.....	.....	8,256
Twin Mounds—Mesaverde	235,417	809	.....
West Kutz—Dakota	66,755	1,601	.....
West Kutz—Pictured Cliffs	10,359,224	1,448	.....
Wildcat	694,069	4,078	.....

* Straight Gas Fields not Included.

	Oil	Gas	Dry	Total
Wells Completed:	6	353	57	426
Number of Producing Wells:	124	1527	....	1651

Number of Pools (Gas and Oil):—34
Pools created in 1954:—12

Total Condensate Produced	328,603 barrels
Total Oil Produced	592.707 barrels
1954 Oil and Condensate	921,310 barrels

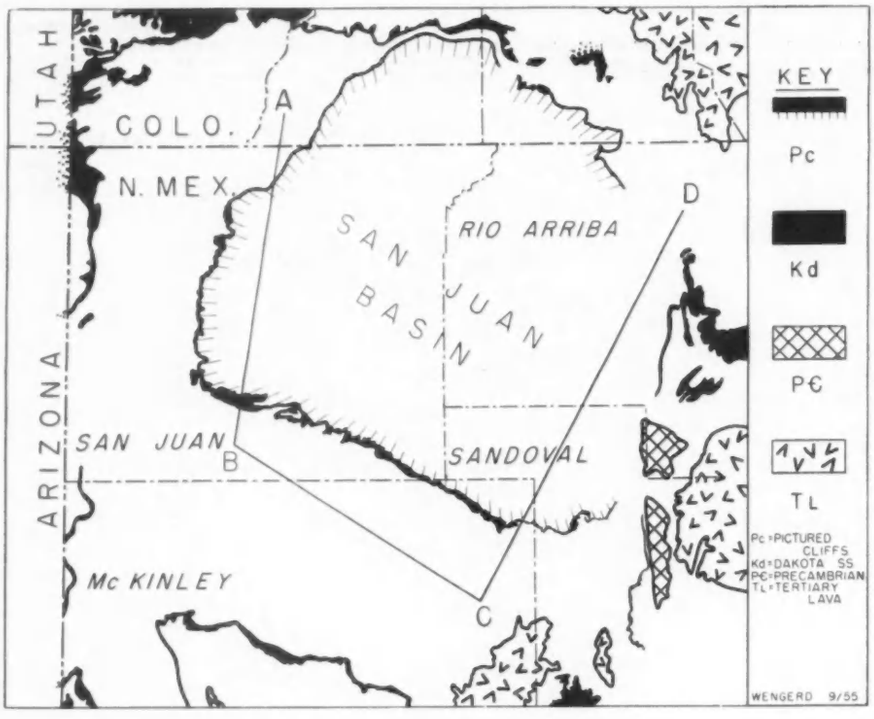

FIGURE 4—Index to upper cretaceous stratigraphic cross sections.

must be sought by all geologists attempting to bring the San Juan Basin to the full oil production indicated by its potential as a geologic province.

One. Have enough wells been drilled to allow accurate subsurface appraisal of the San Juan Basin?

Two. Have the wildcat wells drilled to date been located for structural reasons alone, and, if so, were they correctly located on these surface structures in such a manner as to test the optimum location on the structure in depth?

Three. Have enough wells been drilled deep enough, have they been drilled carefully, and adequately tested?

Four. Have we drilled enough wells on each large surface structure to obtain control on the tectonic history of that field?

Five. Have we tested enough structural noses, terraces, faults, or areas of high joint concentration?

Six. Have we obtained sufficient, accurate well data such as drill-stem tests, pressures, water analyses, cuttings, cores, etc., from the wells already drilled?

With few exceptions the answers to these questions must be "no." The logical approach to a concentrated oil search in the San Juan Basin appears to lie in recognizing first of all that the San Juan area was not a separate sedimentary basin at any time that sediments were being deposited which are now known to contain commercial oil.

Secondly, the explorationist must realize that oil is always found in shelf and basin lithologic associations which encompass maximum, marine sedimentational changes. These changes, with associated disconformities, exist in broad areas of the San Juan Basin, but are almost wholly unrelated genetically to the basin configuration as known today (Figures 2, 3, 4 and 5).

Thirdly, the complications of Laramide and Tertiary tectonism have resulted in prominent structural closures which have thrown us off the track, and the drilling of the majority of wildcat oil tests has been done for structural reasons alone. Very recent major oil discoveries in the San Juan Basin are in areas of no or little surface evidence of structural closure, proving that sedimentational and stratal variations in Cretaceous rocks related to the south and southeast shelves of the Rocky Mountain geosyncline are far more important in oil localization than the subsequent Tertiary differential subsidence to form the San Juan Basin (Figures 5, 6, and 7).

Fourth, because of the Tertiary subsidence and consequent upturning of stratal edges of rocks containing petroleum (Figure 2), certain important shifts in oil accumulation may have occurred near the present basin edge, as well as toward the center of the present basin in the more porous, widespread blanket sandstones.

Because of the complex variables which appear to control oil genesis and accumulation in the San Juan Basin, it is surprising that any oil has ever been found in this basin; this does not mean, however, that abundant new oil production will not be found, for, as more wells are drilled, the variables governing genesis, migration, and accumulation will be better understood and structural exploration will be de-emphasized.

REGIONAL GEOLOGIC HISTORY

The longer the petroleum geologist works in a region, the more he realizes that the historical approach to geology will lead him to a recognition of the controls that affect the accumulation of oil.

Although the Paleozoic history of the San Juan area is complex enough, the regional disintegration of broad sedimentational shelves, marine accessways and uplifts during late Mesozoic and Tertiary time resulted in a compounding of these complexities to form structural basins, active ringing uplifts, volcanoes, bodily uplift of the region to 6000 feet, and serious climatic changes.

The San Juan Basin is stratigraphically divisible into six major layers of diverse enough origin to warrant separate discussion (Figures 2 and 8). The diversity of their origin stems from the differences in tectonism, presence or absence of epeiric seas, difference in rates of subsidence, and difference in types of sediments available to the depositional medium. Only two of these layers have all the characteristics so necessary for successful oil production.

Cambrian to Early Pennsylvanian (Layer No. 1). Northwestern New Mexico, early in its Paleozoic history,

was an easterly high shelf to the Cordilleran geosyncline; in fact, a great part of this area may have been the southwest edge of the San Luis upland of the Siouxian craton.

All pre-Pennsylvanian strata are very thin to absent in this part of New Mexico. The seas that did spread over this high shelf deposited carbonates and some quartzose sands with interbedded non-marine variegated shales such as the Elbert shale of Devonian age and the earliest Pennsylvanian Molas shale. Widespread marine and sub-aerial disconformities are conspicuous and many of the carbonates were dolomitized during still-stands of the thin, warm seas. These rocks thus show a high intercrystalline and solution type of porosity, but they have contributed only very minor amounts of high-gravity oil, associated with nitrogen, carbon dioxide and helium gas (Figures 6, 7 and 8).

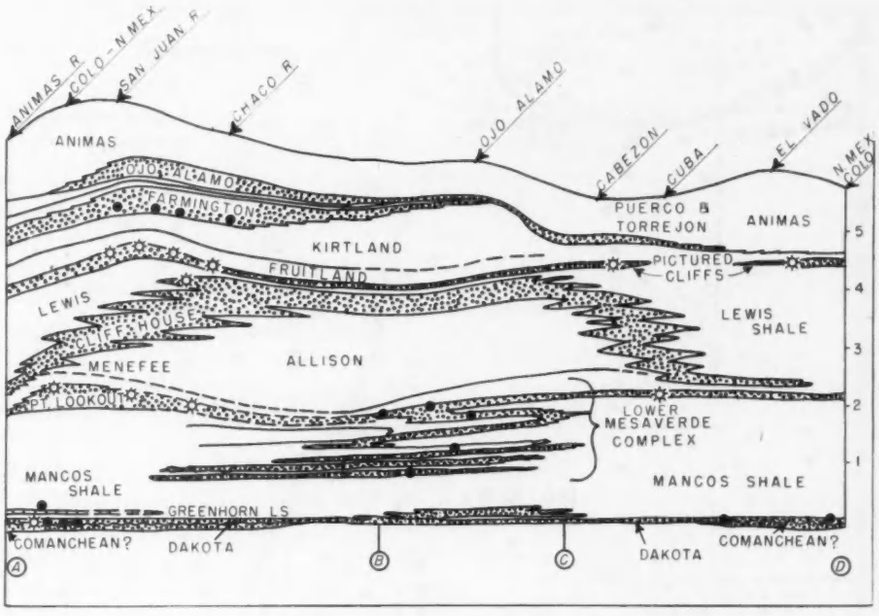

FIGURE 5—Late cretaceous stratigraphic cross section San Juan Basin. NOTE: See index map (Figure 4) for location of letters.

High rates of lithofacies and thickness changes in this first layer are negligible; being essentially widespread porous carbonates, they have participated widely in all the structural, dynamic, and volcanic "accidents" which affected the area since Mississippian time. They can be expected to contain commercial oil accumulations only accidentally in the San Juan Basin, and these accidents could include:

A. Overlap of Pennsylvanian strata onto older carbonates encompassing intercrystalline or secondary porosity;

B. Imbibation from superjacent shale bodies via fracture accessways and fortuituously-timed water immersion.

Pennsylvanian (Layer No. 2). Early Pennsylvanian rocks (the Molas and Pinkerton Trail formations) are essentially of high shelf origin and show some erratic lithologies and thickness variations. The subsidence of the Paradox geosyncline obliquely southeastward from the Oquirrh Basin of northern Utah, across southeastern Utah, southwestern Colorado, and northwesternmost New Mexico, created a locale of highly specialized sedimentation.

This geosyncline encompassed strong tectonism along the northeast side in the Uncompahgre-San Luis-Nacimiento coarse-clastic supplying highland, a broad locale for shelf carbonate and reef formation along the southwest and basinward from the fine-clastic producing positive area now represented by the Zuni-Defiance-Kaibab uplifts, and during Cherokee (early Des Moines) time, an anomalous evaporite-black shale sequence along the axis of the Paradox geosyncline.

The expression of this important Paradox geosyncline in the San Juan Basin area was that of a marine, carbonate-depositing accessway from the evaporite seas southeastward, thence southward between the south end of the Nacimiento uplift and the southeast end of Zuni uplift into the Lucero basin of New Mexico (Figure 6).

With coarse clastics moving into this Pennsylvanian marine accessway from the northeast, fine clastics from the southwest, evaporites and possible reefs forming on the northwest, and carbonates being deposited in the accessway, the area of the San Juan Basin is definitely one of maximum lithofacies and thickness changes within the Pennsylvanian rocks.

Pennsylvanian oil has been found in commercial quantities in the Rattlesnake and Hogback fields, both of which are Laramide anticlines that may have been in existence earlier as structural closures on the large tectonic welt extending southwestward from the San Luis highland (in the vicinity of Durango, Colorado) toward the north end of the present Defiance uplift, to form the southeast side of the Four Corners platform. Since very few deep wells have been drilled to Pennsylvanian rocks within the hogback of the San Juan Basin (Figure 6), this 10,000 square mile area is essentially a new frontier for deep (9000 to 14,000 feet) oil exploration (Figure 2).

Permian to Jurassic (Layer No. 3). This layer, with relatively inconsequential remnants of marine beds, is essentially of continental fluviatile origin, with some wind-blown clastics incorporated. Although oil in noncommercial quantities has been recovered from the Shinarump sandstone and the Entrada sandstone of the San Juan Basin, the oxidized nature of the reservoir strata, absence of widespread, thick lake and swamp deposits, and the presence of large quantities of fresh water presumably makes Layer No. 3 a poor prospect for the discovery of large quantities of oil.

Early Cretaceous (Layer No. 4). Early Cretaceous strata are thin, discontinuous, continental to marginal, marine clastics which are capable of producing appreciable quantities of hydrocarbon gas, but no commercial oil has yet been found. Abundant

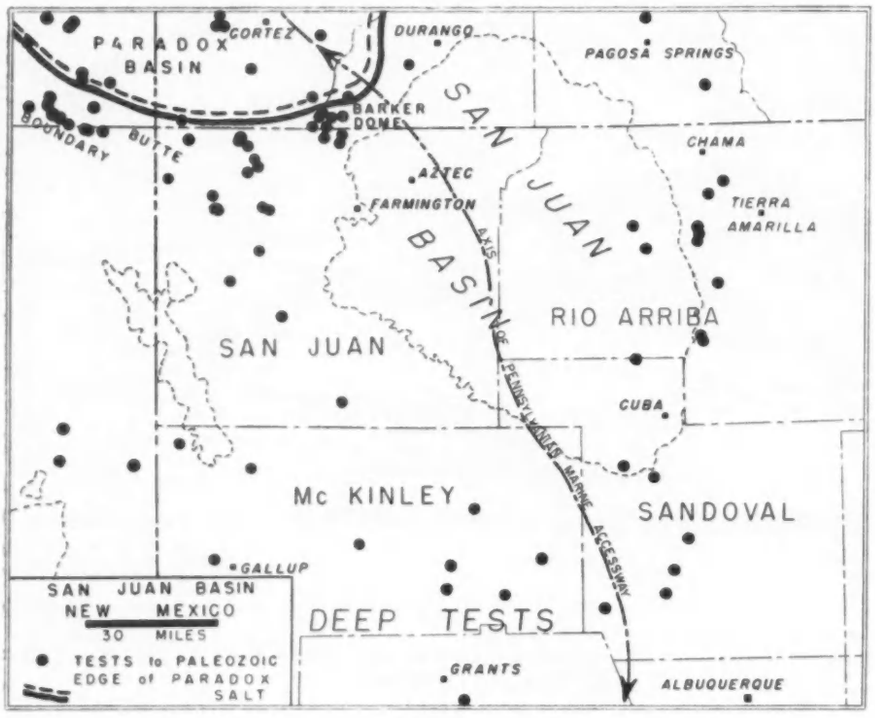

FIGURE 6

fresh water has been found in these strata. They are believed to be weathered and redeposited sediments derived from the Morrison formation below. Only in a fortuitously correct association with superjacent upper Cretaceous sediments could one reasonably expect the thin lower Cretaceous strata to contain oil in commercial quantities.

Late Cretaceous (Layer No. 5). Late Cretaceous seas advanced over the San Juan Basin area from the north and east, clearly relating the San Juan area to the newly-formed Rocky Mountain geosyncline whose deepest parts lay in northerly directions. Most of the medium clastics in this highly important system came from the west, wedging and grading northeastward complexly into marine shales. Here, as in the Pennsylvanian strata, are found extremely complex marine facies and thickness changes in the San Juan area. Transgressions and regressions in early hemicycles of Dakotan to Coloradan age (lower Mesaverde complex, Figure 5) were succeeded by completely cyclic transgression-regression during Montanan time to form the highly variable Mesaverde sequence.

From these strata have come by far the greater amounts of commercial oil in the San Juan Basin (Figure 8). These strata today are yielding important new discoveries each month, and they have the greatest potential for shallow oil in the San Juan Basin.

Cenozoic (Layer No. 6). Lying over broad reaches of the San Juan Basin are the Puerco-Torrejon strata of Paleocene age, the San Jose formation of Eocene age, and Quaternary sands (Figure 2). Although these strata are believed to have virtually no oil potential, they record the maximum subsidence of the San Juan area to form the structural San Juan Basin as we see it today. Tertiary volcanism had little or no effect on the oil potential of the San Juan Basin.

A summarization of the regional history would be incomplete without noting the importance of the non-marine "layers." The same waters which deposited alluvial materials during non-marine deposition of Permian, Triassic, and Jurassic time, may well have had a profound effect on rearrangement and relocation of certain types of oil accumulation in the subjacent Pennsylvanian rocks.

Similarly, the waters responsible for the deposition of strata from the Fruitland formation to the San Jose sandstones may well have moved diversely underground during the Laramide orogeny and the Tertiary basinal subsidence to rearrange certain types of oil accumulations in the more porous blanket sandstones of the Upper Cretaceous sequence.

Last, but certainly not least, climatic variations in Miocene, Pliocene, Pleistocene, and Recent times probably were responsible for a complex interplay of overlapping hydrodynamic and geodynamic forces which resulted in certain shifts and rearrangements in shallow oil accumulation within the more porous widespread layers of Cretaceous strata of the San Juan Basin.

OIL FIELDS

Paleozoic Rocks. The two single-well oil fields of the San Juan Basin which produced near-commercial quantities of oil from the Leadville-Ouray carbonates are Table Mesa and Hogback, both of which have had long productive histories of oil from the Dakota sandstone at shallow depths (see Oil Fields Map, Figure 7).

The oil was of paraffin-base and had a gravity of 52 degrees in Table Mesa field, and 69 degrees in Hogback field. Both wells went to water after about a year of production, and both produced quantities of non-inflammable to barely inflammable gas. One deep well at Hogback field was plugged back to the Hermosa limestone and is now producing 58-degree gravity oil with inflammable gas. Two deep wells at Rattlesnake field have produced almost a half million barrels of 40-degree gravity oil from the Hermosa limestone, but were abandoned after going to water.

Two noteworthy observations may be made here, namely: The Mississippian oil production is on the northwest rim of the present San Juan Basin, but is genetically related to pre-Pennsylvanian high-shelf carbonates controlled in their distribution by the tectonic relationships of the Cordilleran geosyncline and the San Luis positive area; the Pennsylvanian Hermosa oil production is obtained from carbonate sections whose lithology, porosity, and distribution prove them to be related to the southwesterly shelf of the Paradox geosyncline.

Of even greater significance in the emplacement of Paleozoic oil is the fact that it is found in anticlines known to have suffered sharp folding

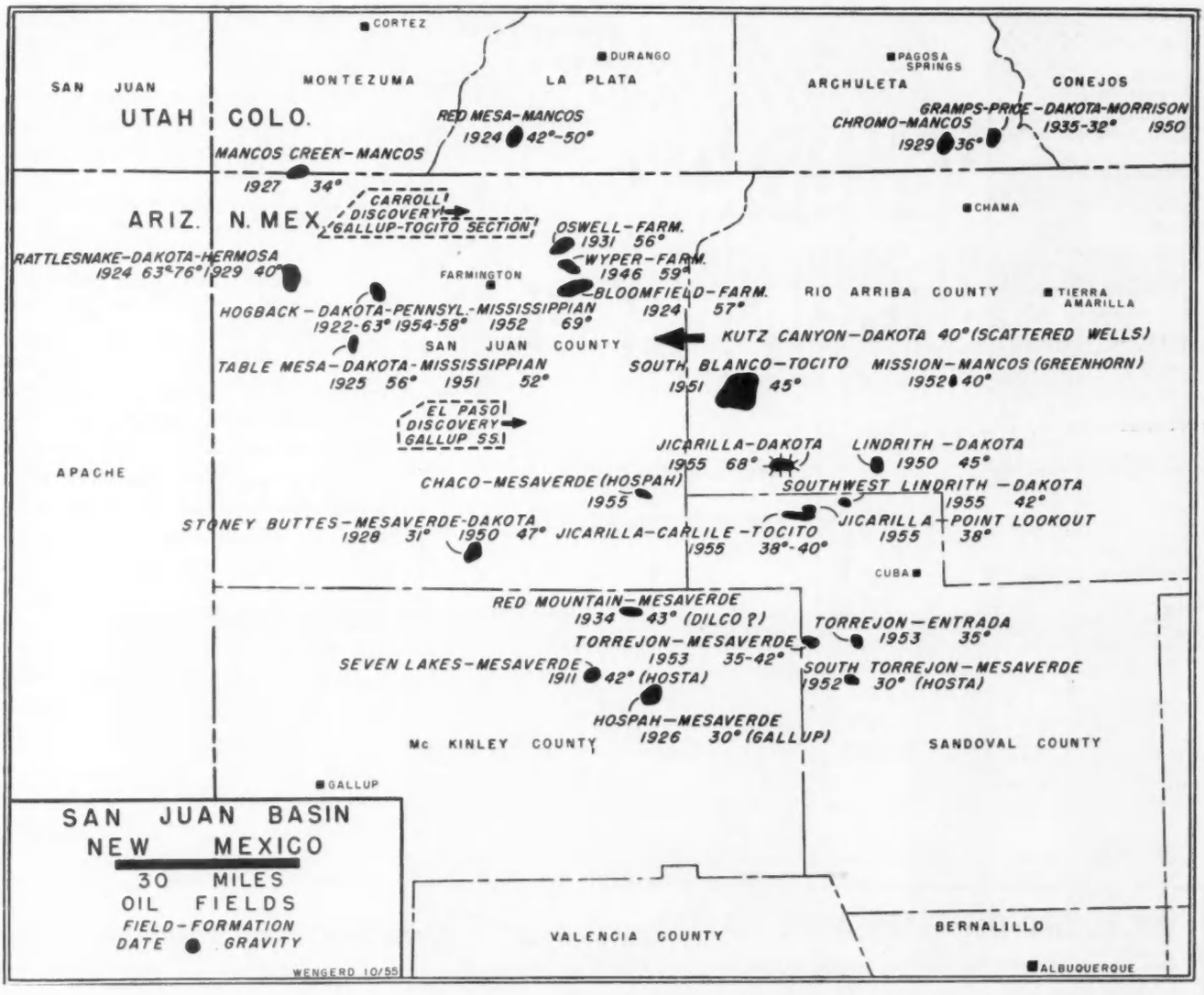

FIGURE 7

during the Laramide orogeny at the end of Cretaceous time, and further that the predominant reservoir drives are saline brines. The inference may be made that Hogback, Rattlesnake, and Table Mesa folds, and still others as yet undiscovered because they were not sharply refolded during Laramide time, are Pennsylvanian and Permian folds developed along the hinge-lines of the Paradox Basin in response to the Uncompahgre tectonism that so vitally affected sedimentation to form late Pennsylvanian Hermosa and early Permian Cutler strata.

Mesozoic Rocks. The greatest number of oil fields in the San Juan Basin are productive from the Mesozoic rocks (see Table I and Figure 8). The Oil Fields map (Figure 7) shows their locations, productive formations, dates of discovery and gravity of the oil. Certain high-gravity oil and condensate discoveries (now of tremendous economic value) related to the San Juan Basin gas fields are shown in Table I, but are not listed on the map.

The Mesozoic oil fields fall rather naturally into five major groups (Figure 7). The Dakota oil fields of the northwestern San Juan Basin, including the Gramps-Price field in the northeastermost San Juan Basin; the Mesaverde (Dilco to Hospah-Gallup) oil fields of the Chaco slope in the southern San Juan Basin; the Farmington sandstone oil fields near Aztec and Bloomfield in the northwest-central San Juan Basin; the Mancos fractured shale oil fields extending from the northwestern San Juan Basin in an arc through the northwestern and eastern San Juan Basin; and the highly important 1951 to 1955 discoveries in the Hospah-Gallup-Tocito-Sanastee-Carlile-Upper Dakota sections extending in a northwest trend from Cuba, N. M., to the Ute Dome area of the northwestern San Juan Basin.

Inasmuch as the upper Mesaverde to Dakota section of the upper Cretaceous series shows the highest rate of sedimentational change involving claystone, siltstone and sandstone facies, the greatest number of non-

For other articles on the Rocky Mountain area, see Current Outlook, Drilling, and Production sections of this issue.

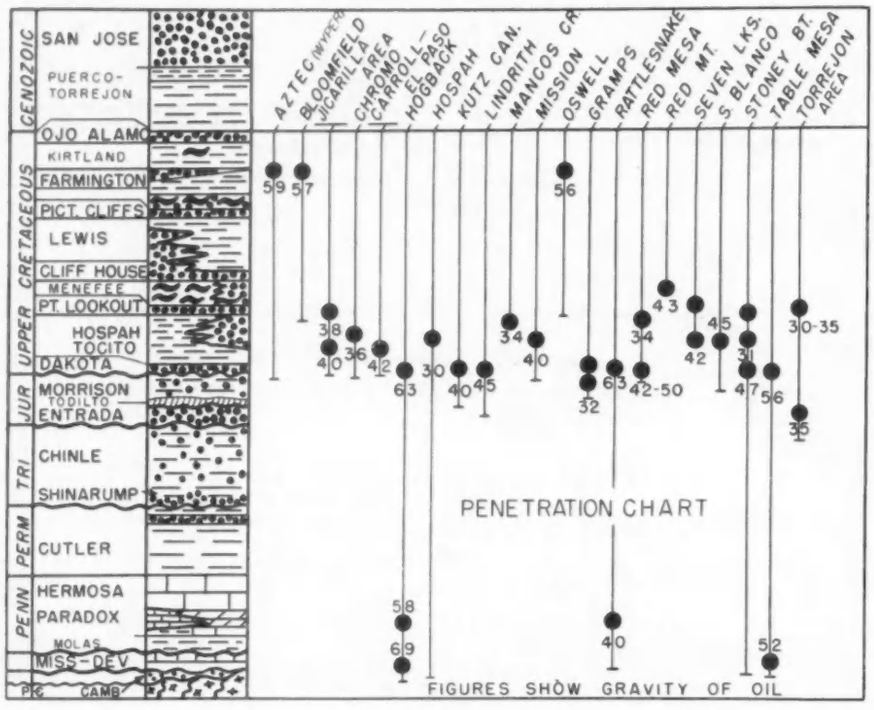

FIGURE 8

structural oil accumulations should be found in this section.

The presence of fresh water as the driving element in the northwest San Juan Basin Dakota oil fields appears to indicate that these structural accumulations are adjustments to fresh water incursion and consequent rearrangements of brackish water genetically related to in situ oil generation in the blanket Dakota sandstone. Although not seriously tilted, the Dakota oil-water contacts in these anticlinal accumulations (which lie athwart the northwest low-dip spillway of the San Juan Basin) and the small areas of Dakota oil accumulation in relation to areas of closure in these Laramide-rejuvenated structures, strongly suggest that the oil was retained in the Hogback, Table Mesa and Rattlesnake anticlines in a dynamic balance related to complex hydrodynamic forces involving fresh waters which have been on the move since mid-Tertiary time. It is suggested that this high-gravity Dakota oil (56°-76°) is Dakota condensate which originated in situ, mixed with oils driven by compaction into the more porous Dakota sandstone from the superjacent lower Mancos shale.

The Mesaverde oil fields of the Chaco slope have a remarkably narrow range in oil gravity. The type of

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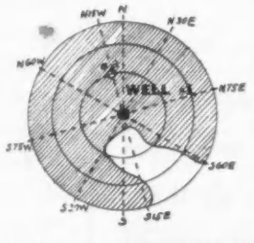

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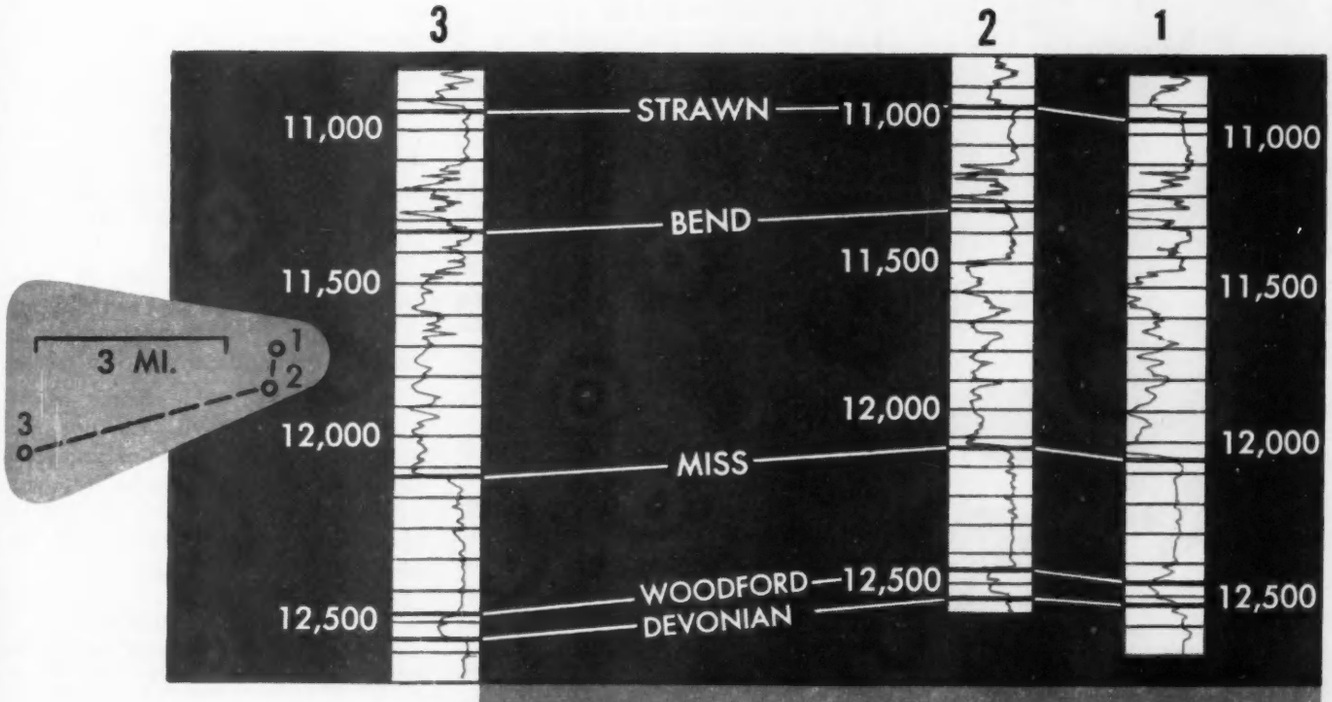

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About the Author

DR. SHERMAN A. WENGERD, associate professor of geology, University of New Mexico, received his Ph.D. in geology from Harvard University in 1947. He has been a consulting research geologist in the Four Corners region and is a former president of the Four Corners Geological Society. He also worked as research geologist for the Shell Oil Company in the Tulsa division, and saw wartime service as geologist for the U. S. Naval Petroleum Reserves.

oil and the presence of fresh water as the motive and retentive agency in the reservoirs suggests that these oils were derived both in situ and from the interbedded Mancos shale tongues, with some oxidation-modification by fresh and brackish waters.

The Farmington sandstone oil fields are found in a continental, cross-bedded sandstone enclosed in the dark gray fluviatile and lacustrine Kirtland shale. Gravity of this anomalous oil ranges from 56 degrees to 59 degrees. Some local geologists believe that this oil migrated into the eastward-wedging Farmington sandstone lentils from depth, and may represent lighter components of deeper Mesaverde oils which have suffered vertical transmigration. The never-failing existence of fresh water with this high-gravity oil suggests strongly, however, that the Farmington oil was of continental organic origin.

The Mancos fractured shale oil fields occur in silty phases of the Mancos, correlative with sandstones and thin limestones in more southwesterly sections of the San Juan Basin. The 34-degree to 50-degree gravity oil is believed to have formed in situ and to have moved into fractures which were initiated during the Laramide orogeny, and enlarged along hinge areas as Tertiary subsidence of the San Juan Basin took place.

The last of the five types of Cretaceous oil accumulation extends in a broad band from the southeastern to the northwestern San Juan Basin. Discovery of the South Blanco Tocito field in 1951 led to projection of trends of neritic sand development in the lower sandstone hemi-cycles of the Mancos shale, ranging from 600 to 1200 feet above the top of the Dakota sandstone. These accumulations are being explored with vigor now, and during September alone two major discoveries were made (see arrows on Oil Fields map, Figure 7).

The wide variation in oil gravities, general lack of fold-type structural closure, lack of fresh water and wide variation of pressures and gas contents are highly suggestive of porosity and permeability variation traps in lensing sandstones not directly connected to, but correlative with, sheet-like sandstones which crop out far to the southwest and east.

The trend of these fields, whose potential and extent are not yet known because of recency of discovery, clearly relates them genetically to the sedimentational shelf of the Rocky Mountain geosyncline, rather than the structural San Juan Basin.

ACKNOWLEDGMENTS

The writer is indebted to the oil and gas companies and independent operators with whom he has been privileged to work as a petroleum consultant; to William B. Macey of the New Mexico Oil Conservation Commission for production data; and to the New Mexico Geological Society, before whom this subject was presented as a formal illustrated lecture at their 1955 Annual Meeting in Gallup, New Mexico. The reader is referred to the Geological Symposium of the Four Corners Region, Four Corners Geological Society 1952 (out-of-print) for a complete bibliography of Northwestern New Mexico, and to the Four Corners Geological Society Field Trip Guidebook, June, 1955, for the latest technical papers covering this area. This leatherette-bound guidebook of 217 pages is available from the Four Corners Geological Society, P. O. Box 1121, Durango, Colorado, for $7.50.

Wildcats have moved . . .

WORLD OIL's monthly report on wildcat drilling in the U. S. will be found this month on Page 112. And just preceding it, in one convenient package, you'll find our other monthly features, Petroleum Trends in the U. S. and The Month's Completions.

Rocky Mountain Drilling Practices

In the Williston Basin, a 500 foot salt section is commonly encountered. In such cases a salt-base mud or gyp-base mud is used.

Adaptability to terrain and climate, and the modification of equipment has helped to reduce time and cost in this oil frontier.

By C. H. GRIFFIN,
R. L. Manning Company, Denver

FOR MANY YEARS drilling operations in the Rocky Mountain Area were considerably handicapped in comparison to drilling techniques in the more active areas in the Mid-Continent and West Coast. Relatively few wells were drilled. Fields and wildcats were separated by many miles. High altitude and extreme winter weather presented difficult operating problems, and in general, progress in drilling encountered many obstacles until the end of the second World War. Commencing with the Rangely boom in 1946, many new operators and drilling contractors came to the Rocky Mountain Area from the Mid-Continent and the West Coast and brought with them new techniques and ideas. Manufacturers developed new equipment and critical materials again became available. These factors, coupled with a strong competitive spirit in the industry, have affected drilling operations in the mountain area. However, a great many of the problems of distance, terrain, and weather continue to plague the Rocky Mountain operators, and many of the techniques developed for drilling in this area are quite distinct from those used in other areas of the country.

A resume of some of the more important drilling problems, and a discussion of some of the means of solving them, are outlined as follows.

Hard Drilling Areas. In most areas of the Rocky Mountains formations are hard and abrasive. Penetration rates therefore are comparatively slow and bit life comparatively short. In Wyoming, the Wind River, Laramie, Big Horn and Green River Basins are good examples of areas noted for their hard drilling characteristics. Formations at the surface are usually Cretaceous, and producing horizons are in the Pennsylvania or older beds. Hard formations also are encountered in the Uinta Basin and Western Colorado areas where as many as 200 bits

are required to drill to 10,000 feet. Relatively hard formations are encountered also in the Williston Basin of Montana and North Dakota.

Soft or medium-soft formations are encountered in the Denver-Julesburg Basin of Colorado and Nebraska, and in the Powder River Basin of northeastern Wyoming. Hard rock drilling requires the use of rock bits exclusively and many types of short toothed hard formation bits are in use. Jet bits are commonly employed in the areas of faster drilling but are not usually used in hard formations. The use of jet bits has required the utilization of larger high-pressure pumps with 18-inch stroke, powered by 600 to 800 horsepower engines. The larger rigs generally have one high-pressure pump with a 14 or 16-inch stroke pump installed nearby for standby and compounding purposes. The development of pulsation dampeners for use on the mud discharge line has made it possible to compound two power pumps effectively, and this practice is finding more widespread use particularly in deep holes. Smaller rigs drilling 5000 feet and less continue to use only one pump, but the size of the single pump is steadily increasing.

Most Coring With Diamond Heads. The use of diamond bits was pioneered in the Rocky Mountain area. Almost all coring is now done with diamond core heads because of the good penetration rate and excellent recovery. Diamond core heads and core barrels are supplied by service companies on a footage basis charge, with the result that the risk to the operator of losing an expensive diamond head in the hole is completely eliminated. Most common sizes presently in use are 6⅛, 7⅞ and 8¾-inch. Where extremely hard formations are encountered, diamond drilling bits are widely used. In the Wind River Basin, sections of the Tensleep Sand and Madison Lime are drilled with one diamond bit which can be left on bottom for 48 hours or longer. Conventional rock bits formerly in use would be dulled after two to four hours in these formations. In some cases, only one diamond bit has drilled an interval which required as many as 10 or 12 rock bits.

Percussion Bits for Chert Sections. Sections of chert encountered in the Wind River Basin, the Green River Basin, and Eastern Idaho, have proved to be almost impenetrable with conventional rock or diamond bits because of their abrasive action on conventional rock bits and tearing and destructive action on diamond bits. To penetrate these very hard cherty formations crushing type bits have been used. These are three-cone roller type bits heavily studded with tungsten carbide inserts which crush the formation.

About the Author

C. H. GRIFFIN was graduated from Stanford University in 1935. After working for Shell Oil Company in Los Angeles, he went to the Rocky Mountain area in 1946 as production superintendent for Wasatch Oil Company, Salt Lake City. When Phillips Petroleum Company bought Wasatch in 1948, Griffin moved to Casper, Wyo., as division superintendent of the Rocky Mountain area. In 1953 he joined R. L. Manning Company in Denver. He is now chairman of the API Rocky Mountain District Committee on Drilling Practice.

In many locations of the Big Horn Basin and Williston Basin, it is common practice to utilize extremely heavy strings of drill collars in order to attain weights on the bits of from 50,000 to 75,000 pounds. Usually, large diameter drill collars are desired to get the maximum weight as close as possible to the bit. Common sizes in use are 8¼ or 8-inch outside diameter collars inside 9-inch diameter hole. In 7⅞-inch hole, 6¾-inch and 7-inch OD collars commonly are used. Such collar sizes have been quite effective in improving the rate of penetration in Rocky Mountain drilling operations. Rotating speeds are usually maintained at 100 revolutions per minute or less in the hard formations. In the Denver-Julesburg Basin, it is common practice to spin the drilling string at 250 rpm or higher and this practice is spreading to the Powder River Basin and other areas where soft formations are drilled.

A few automatic drilling devices are in use on the large rigs. One company employs such a device on a rig in the Wind River Basin and contends that the equipment has increased penetration rates through maintaining constant weight on the bit. Automatic drilling devices are not in common use, however, because of the difficulty of justifying the high initial cost and maintenance. Both air and gas drilling have been found effective in increasing the rate of penetration. These techniques will be described farther on in this article.

For many years it was considered impractical to set whipstocks for straightening hole or drilling slant holes. This was due to the difficulty of getting the bit to start a new hole in the very hard formations, the tendency being for the bit to drill back into the old hole. However, in recent years better types of bits and improvements in whipstock equipment and techniques have made it possible to do this more successfully. However, the use of directional holes drilled from one location in the manner of Gulf Coast and West Coast drilling is seldom used in the Rocky Mountain area because of high costs.

There have been a few tests of drain hole drilling where several slant holes are drilled from the single bore hole near the bottom of the well. Mechanically these jobs were successful, but the thin pay sections and high costs have so far prevented this practice from becoming widely used.

Stabilizers Help Solve Crooked Hole Problems. Crooked hole is one of the most persistent obstacles to drilling progress in the Rocky Mountain area. Relatively hard formations lying in beds at steep angles constantly plague the drillers in making hole in many of the hard formation areas. The innovation of stabilizers has been of considerable help in overcoming crooked hole problems. Stabilizers are being used more and more in the Wind River and Big Horn basins. Both the rubber and metal sleeve type stabilizers are in use, and much experimental work is being done in an effort to determine the optimum position for stabilizers in the drilling string. Formulae and field tests are being used to determine proper ar-

rangements of stabilizers for the different formations encountered.

Two-cone bits are commonly used to maintain straight hole. The life of these bits is not as great as that of three or four-cone bits, but this type of bit has been quite effective in reducing deviation troubles. Large diameter drill collars which provide the stiffest possible drilling string also have been effective in combating crooked hole, but the investment is high and the risk of losing collars in the hole is great with the result that most contractors have been hesitant to use them.

It is a proved fact that increasing the rotating speed helps in maintaining straight hole. However, high rotating speeds result in increased wear on the drill pipe and tool joints and cause kinked pipe and twist-offs at the greater depths. The effect of steeply dipping beds in the areas of rapid drilling is much less than in hard drilling country. No appreciable crooked holes are encountered in the Denver-Julesburg Basin, and only moderate problems exist in the Powder River Basin. Generally speaking, the drilling techniques developed in the last 10 years have overcome only a small degree of the troubles caused by hole deviation. Great improvement is still needed in this regard.

Better Mud Programs Reduce Lost Circulation. Lost circulation also is a serious problem in the Rocky Mountain area. In almost all of the basins of Utah, Wyoming and Montana lost circulation is a serious threat to drilling progress. The problem has partially been solved by improvements in drilling mud qualities. Chemical treatment and control of mud were somewhat slow in arriving in the Rocky Mountains but much has been done in recent years to improve drilling hydraulics. Many of the oil companies and a few drilling contractors have mud engineers to supervise mud programs. However, mud supply companies have been largely responsible for providing engineering services to the drillers, and generally have been responsible for the improvements made. Experience in drilling certain formations has led to the knowledge of what types of mud are best for various areas. In the Denver-Julesburg Basin where no lost circulation troubles are encountered, clear water is used to drill to the Niobrara Shale which is heavily interbedded with bentonite. At this point a gel mud is used to replace the clear water, and only very little chemical additives are necessary, for the maintenance of a very satisfactory drilling fluid. Swelling of the shale and hole sloughing are largely prevented by the addition of 20 percent of 36 gravity or higher crude oil. Water losses as low as 3 cc are readily obtained by the emulsification of crude oil with the gel.

In the Williston Basin, a 500 foot salt section is commonly encountered and in such cases a salt-base mud or a gyp-base mud is commonly employed. In the Big Horn Basin and Wind River Basin where Triassic Red Beds are encountered, considerable difficulty is caused by the contamination of the mud with anhydrite. To combat this problem, lime-based muds frequently are used. The use of 20 percent crude oil or diesel oil in clay-water muds is receiving wide-spread acceptance. The oil allows greater bit life and less abrasive wear on the drilling string. It also helps to maintain low water losses with resultant decreases in hole sloughing and swelling of bentonite particles. Low water loss muds are also very desirable when drilling the producing zones.

The use of four-man crews is becoming more and more commonplace. On rigs drilling to 6000 or 7000 feet in the Denver-Julesburg basin, four-man crews are almost universal. Four-man crews are prevalent on rigs in Wyoming drilling to 5000 feet. Five-man crews are still used on deep wells.

Many wells in the Denver-Julesburg basin are drilled on a turn-key basis with the drilling contractor furnishing everything to the point of setting oil string. This has been brought about by drilling contractors who frequently own an interest in the venture and are perfectly willing to assume the risk of furnishing mud, core heads, etc. in this area of little drilling difficulties. The practice is not common in other areas of the Rockies because of the high risk of hole trouble, lost circulation, coring difficulties, etc.

Rigs Dismantled For Moving. Hoisting equipment used in the Rocky Mountain area is generally lighter in weight than that employed in Gulf Coast or West Coast areas. Rigs in these areas must be dismantled for almost every move and frequently must be fitted into tight locations where space can be had only by expensive excavation. As a result, horse power on most of the rigs is considerably less than that used in other areas. However, as engine designs are improved and other innovations, such as torque converters, made available, rigs have been taking on more power in recent years. Probably in no other area are small rigs taken to such great depths as in this area. One contractor currently is drilling a well below 15,000 feet with a standard rig rated for 6500 to 10,000 foot depths and powered by 950 hp on the drawworks. Because of the difficulty of erecting derricks in the high wind and adverse weather conditions, the use of masts has largely replaced conventional derricks. Only the largest rigs in the area still utilize derricks and these are being replaced at a rapid rate.

Long Moves Typical. Transportation of drilling equipment from one location to another has long been a major problem in drilling operations. Oil fields are relatively small and drilling programs are rarely sustained in one area, so long moves are a regular practice. The average moving job for contractors' rigs is between 100 and 200 miles, and moves of from 500 to 1000 miles are not uncommon. As a result, all drilling equipment is designed for ease of moving in relatively small loads.

Each spring, during the thaw, the state highway departments of Montana and North Dakota greatly restrict the loads which can be transported on state highways. As a result, the major items of equipment such as drawworks, engines and pumps are so constructed that they can be separated into small loads for moving. Auxiliary equipment such as mud pits, racks, tool houses, tanks, etc., are simplified as much as possible and constructed for ease of moving. Extreme winter weather, particularly in Montana and North Dakota, makes it necessary to have elaborate engine house and steam boilers for the sheltering of the crew and equipment. Fiber glass, reinforced plastics, and aluminum are coming into use wherever possible for such protective equipment. Pipe systems are unitized in the substructure, and the substructures are enclosed in order to simplify the heating problem during the winter. It has been found particularly desirable to keep drilling equipment as compact as possible in all cases

Continued on Page 150

Plastic Foils "Thief Zones"

The addition of plastic foil particles to drilling mud has proved successful in controlling lost circulation in the Rocky Mountain area by bridging pores and fractures in formations.

By AL GIONTA and R. L. DICKSON,
Dowell Incorporated,
Casper, Wyoming

THE USE OF fragmented plastic-foil has proved effective in maintaining circulation in drilling wells in the Rocky Mountain area, as well as a corrective measure, after mud losses have already occurred. The foil consists of crinkled, plastic-foil particles that are graded in size from pinhead diameter to two inches in length. Mixed with drilling mud, the smaller particles penetrate and plug holes in the formation walls while the larger sheets plaster and seal the surface.

As a preventive measure, small quantities of this fragmented plastic-foil, added to drilling mud before penetrating an expected thief zone, have aided in maintaining normal circulation, allowing uninterrupted drilling operations.

The problem of lost circulation is universal wherever rotary tools are used, and is often the forerunner of serious blowouts, stuck drill pipe, difficult fishing jobs, increased completion costs, and in some instances loss of the well.

Drilling of the cap rock on shallow salt domes and certain porous, low pressure, formations is often the cause of lost circulation. The extent of mud loss depends on a number of factors, such as, the size of the mud particles, the viscosity and weight of the mud, wall-building properties of the mud, the hydrostatic head of fluid in the hole, and of course, the permeability and pore size of the formation.

Crewman adding plastic foil particles to the mud system through a mud hopper. This method usually insures even distribution of the particles throughout the mud system.

In deep drilling operations, an increase in the mud weight to control abnormal pressures is the primary cause of lost circulation. Zones which would withstand ordinary pressures may become thief zones when the weight of the mud column is increased. Several general methods of restoring circulation have been used successfully; setting of casing, varying the viscosity or gel quality of the mud, or adding solid plugging agents to fill the pores in the formation and stop the loss of drilling mud.

Setting additional casing is so costly that it is usually employed only when all other methods fail. Moreover, the reduced size of the continued hole may become critical, especially in the

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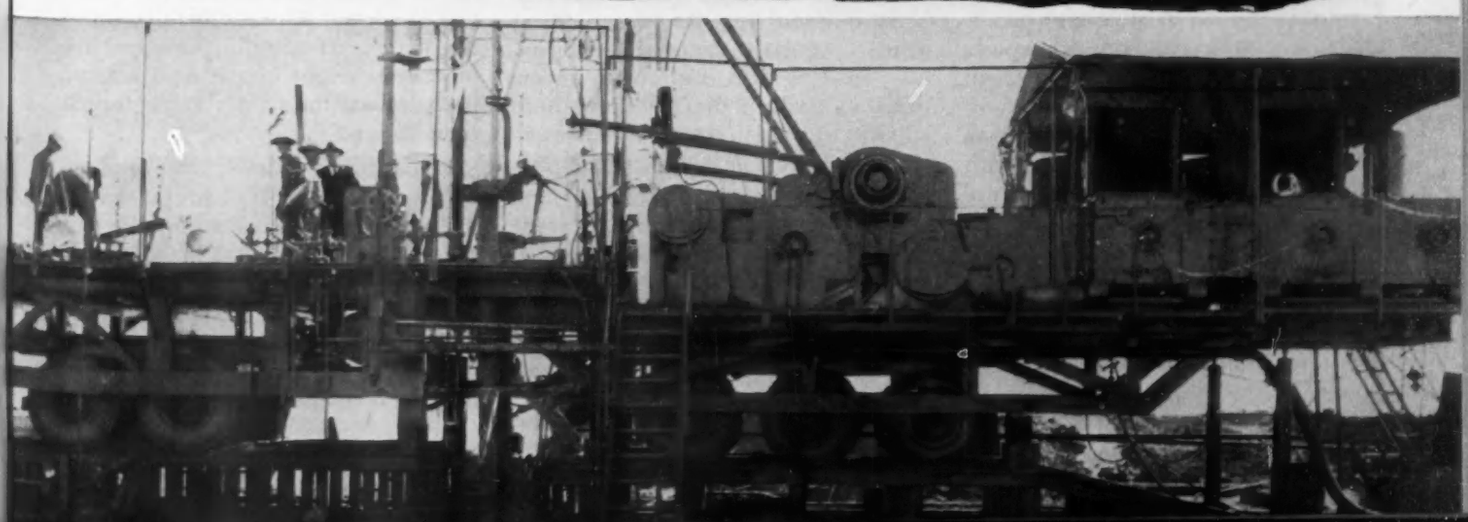
This complete new rig, proven under extreme field conditions, definitely solves the problem and need for portability in a medium depth drilling rig. Another plus is that the operator has a mast of rigid design that can be used under any conditions.

● *Photo at left:* Here is an overall view of the rig with mast extended to full height. Note that the only guys needed are side "wind-guys" attached to outriggers extending from the ramps. The guyless feature saves many hours during rigging up operations and is especially valuable in swampy or rocky areas.

● *Photo below:* An overall closeup view of the two trailers as they are positioned over the hole. The ramps under the trailers are placed so that trailers line up perfectly, with little effort and time. The ramps also provide added height to clear blowout preventers. Note the large working area on the derrick floor.



event of tool failures and subsequent fishing operations.

Increasing the viscosity of the mud by altering the gel quality frequently is effective in restoring circulation, especially when a water zone is penetrated. However, the increased pressures required to circulate this thicker mud exert greater pressure against the formation, thereby tending to create new thief zones. Also, the thicker sheath of mud may be detrimental to subsequent drilling operations.

As a result, the addition of various kinds of pore-filling material to the mud is the method normally used to restore lost circulation. A number of different materials have been employed as lost-circulation agents, such as cotton-seed hulls, grains, wheat bran, chopped-up hemp rope, and wood shavings. Unfortunately, tannic acid, released by many materials of natural origin, tends to thin the mud. Consequently, conditioning agents must be added to restore the desired viscosity. For maximum effectiveness a circulation-loss agent should be selected which will not be affected by water, oil, mud chemicals, bacterial action, or high bottom-hole temperatures. Plastic-foil meets these requirements, and will not appreciably change the properties of the drilling mud. Since its specific gravity is approximately that of drilling mud, it will not adversely affect the weight of the mud column.

The fragmented foil form of the plastic particles, plus their specific gravity, enable them to remain in suspension indefinitely. They do not clog pump valves or circulating equipment. Their crinkled surface prevents them from balling up, or becoming wetted unevenly. Because of their extreme thinness, 0.0001-inch, they can cover an extraordinary extent of formation surface per unit weight; twenty-five pounds have over 500,000 square inches of surface area. These foil fragments are flexible and pliant, enabling them to plate out over rough and irregular surfaces. Foil has high strength, even when wet.

The quantity of foil required to overcome circulation losses varies with field conditions. In fields which are known to contain zones in which mud usually is lost, two pounds are customarily added to each barrel of mud, when such zones are being penetrated. Such application provides considerable protection against loss of circulation. After the troublesome zones have been penetrated, the foil material may be recovered by passing the mud returns over a shale shaker. The recovered foil has been reused several times with good results.

In cases of severe loss, it is usually necessary to increase the amount of foil to as much as 5 to 6 pounds per barrel of mud, in order to secure the desired results. In exceptional cases, circulation has been restored after using as much as 30 pounds per barrel.

Deep wells have been completed successfully by using foil where the pressure at which circulation would be lost and the pressure of the mud column amounted to less than one-half pound per gallon of mud.

The mixing of the foil with drilling mud does not require any special equipment or elaborate procedures. Usually it is added to the mud by means of a hopper attached to the mud suction. Another frequently used method is to add the material to the mud pit, near the mud suction pipe. The mud gun will then provide adequate mixing. When this method is employed, raising the mud suction pipe to within a few inches of the surface of the pit allows a heavy concentration of foil-laden mud to reach the porous section in a slug with better chances of sealing off the thief zones.

Many times, the use of several slugs of mud containing large concentrations of foil has been found to be more effective than larger quantities of mud which contain lesser concentrations of foil, especially if circulation has already been lost. The foil fragments are believed to seal off thief zones as follows: Some of the foil in the mud first entering the larger pores is filtered out, causing the pores to be bridged gradually. This process is cumulative and as additional foil-laden mud reaches the thief zones, the plugging and plastering process continues until all of the pores taking fluids are filled. The plastic material, being thin and very flexible, conforms to the irregular surfaces of the formation, building up a continuous, impervious wall which prevents fluid from entering the thief zones.

A good practice based on field experience is to shut down the mud pumps for several minutes after the first slug of foil-laden fluid reaches the porous zones. The plastering process of the foil previously described, can take place more readily than when the mud is being agitated by pumping.

A treating technique known as a "spot job" is very frequently used to regain circulation in the Big Horn Basin of Wyoming. This has been used on shallow wells (1000 to 5000 feet in depth) in which mud circulation was lost due to small cavernous formations. It has also been used in deeper wells (depths to 10,000 feet) where mud was lost in a fractured type of formation.

This treatment was applied to a well that had lost circulation at a depth of 5000 feet. A mud which was standard for the area had been used that contained four to six pounds of sugar cane fiber per barrel as a preventive measure. To restore circulation, 80 barrels of jel mud (for increased viscosity) containing about four pounds of foil per barrel of mud, was pumped down the drill stem. Standard mud was then pumped into the well to displace the "spot job" material. After displacement was complete, a setting time of three hours was allowed. The mud pumps were then started and their speed increased very gradually. Normal circulation was restored. This type of treatment has been effective on wells throughout the Rocky Mountain area.

At Hamilton Dome, Wyo., circulation is often lost while drilling surface hole. Drillers can usually tell when this thief zone, which they refer to as the "hard bone" formation, is reached because of the rough action of their bit. Under such circumstances, circulation has nearly always been restored when 8 to 10 bags (200 to 250 pounds) of foil were dumped directly under the mud suction and taken to the formation as quickly as possible. This procedure is common practice.

On a well in Golden Valley County, Montana, artesia water flows were encountered at 1600 to 2000 feet in the Cat Creek sand. Drilling mud weighing in excess of 13 pounds per gallon was employed. One to two pounds of foil per barrel of mud prevented the increased weight of the mud column from forcing the mud into the formation.

In Duchesne County, Utah, gas and oil pressures of 5600 pounds per square inch were encountered while a well in the Wasatch formation was being drilled. A heavily weighted mud successfully controlled the high bottom hole pressure, while three pounds of foil per barrel prevented loss of mud into the formation. —**The End**

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Drilling Mud Practices In the Rocky Mountains

A brief sketch of recent drilling mud practices for combating lost circulation, sloughing shales, and water-wetting of pay zones.

By RAY DILLMAN, President,
Mountain Mud Company, Inc.,
Casper, Wyoming

LOST CIRCULATION and swelling bentonitic shales still present the greatest drilling problems throughout the Rocky Mountains. During the last two years, operators and contractors have been combatting the two major drilling problems with a new approach.

In fighting lost circulation, operators and contractors have realized the importance of reducing the hydrostatic weight of the mud column. This is being done by entraining air into the system, or by the addition of oil to the mud. The first method has not proved too adaptable, due to equipment required. However, in extremely bad losses, this method has been used with a fair degree of success. It is possible to reduce the mud weight to 7.5 or 7.8 pounds per gallon with entrained air. Some hole trouble has been experienced with this method, since the carrying capacity of the mud has been reduced to the extent that the hole is not kept clean.

Probably the most serious argument against this method is the reaction that the air will have on the drill pipe, mud lines and rig pumps. Some oxidation has been experienced and has been attributed to the entrained air.

The addition of oil to the drilling fluid to reduce hydrostatic pressures, and combat lost circulation, has proved very successful. The percent added is very flexible, as little as 5 percent to as much as 40 percent have been used. Mud weights can be cut to as low as 7.6 to 7.8 pounds per gallon. Besides lowering mud weight, the oil gives other added advantages in that it reduces hole friction, cuts down mud gelation, and makes it possible to add more pounds per barrel of lost circulation material and still allow the fluid to remain pumpable.

It has been found, also, that a bridge built up in a lost circulation zone with oil in mud will not break down as easily as one built up with straight water-base mud. This is probably due to the fact that the formation is not water-wetted with the oil in mud. In some instances, mechanical emulsifiers are used to tie up the oils completely. This is especially true if circulation is regained and the oil mud is used to drill the remainder of the hole.

The Rocky Mountain shale sections are generally highly bentonitic, and present a drilling problem. They cause bit-balling, resulting in slow penetration; hole bridging, cutting down of trip time, high solids muds and stuck drill pipe. The general practice has been to drill these sections with water, and mud up after they have been drilled. This has not proved to be the best method, either from a practical or economical standpoint.

The chemical emulsion muds are fast replacing the old method of water drilling, resulting in faster rate of penetration and drilling of a hole that will stand up with little or no trouble. The chemical emulsion is thought of as being a fatty acid or soap emulsifier used in either fresh water or lime base muds, the lime base emulsion being used to drill the Red Bed and anhydrous sections. Most of the operators are employing 15 percent to 20 percent oil by volume to make up the emulsion, depending on the type of water loss desired.

These types of muds are affording the following advantages and characteristics: Double the rate of penetration in shale sections, less torque on drill pipe, less hole friction, longer bit life and protection to drill pipe, they keep shale from water-wetting and sloughing, protect production zones from water blocking and afford better well completion. To obtain a less than 2 cc water loss with this type of mud, it is costing approximately $1.50 per barrel of mud over the regular water base muds.

The mixing of the chemical emulsion is no problem, usually being converted from conventional type to the emulsion type with no rig time; being done while on bottom drilling. Also, there are no serious changes in hole conditions that might be expected in changing mud characteristics.

These types of muds, have been used in various places throughout the Rocky Mountains, i.e., Table Rock field, Sweetwater County, Sussex field, Natrona County, Newcastle field, Weston County, and on several wildcats over this area, and are proving to be very successful. —**The End**

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Pile of cuttings removed from 4000-foot air-drilled hole, Government No. 2, in South Little Buck Creek field, southern end of Powder River Basin, Wyoming

Photo courtesy Well Completions, Inc., Denver, Colorado

3876 Feet per Bit with Air

Air versus mud drilling tests in three Powder River Basin completions show that air is far superior.

By E. A. POLUMBUS, JR. and M. S. LEGGE,
Denver

AIR AND GAS drilling operations in the Rocky Mountain area have received additional impetus during the past year from improvements in drilling characteristics noted by contractors and operators in numerous Rocky Mountain air and gas drilling operations. One example of such improvement is found in the completion, earlier this year, of three wells in the South Little Buck Creek field in Niobrara County, Wyoming, in the southern end of the Powder River Basin. These wells are drilled to depths of slightly more than 4000 feet. One of the wells was drilled using mud as a circulating medium, while the other two employed air as the circulating medium.

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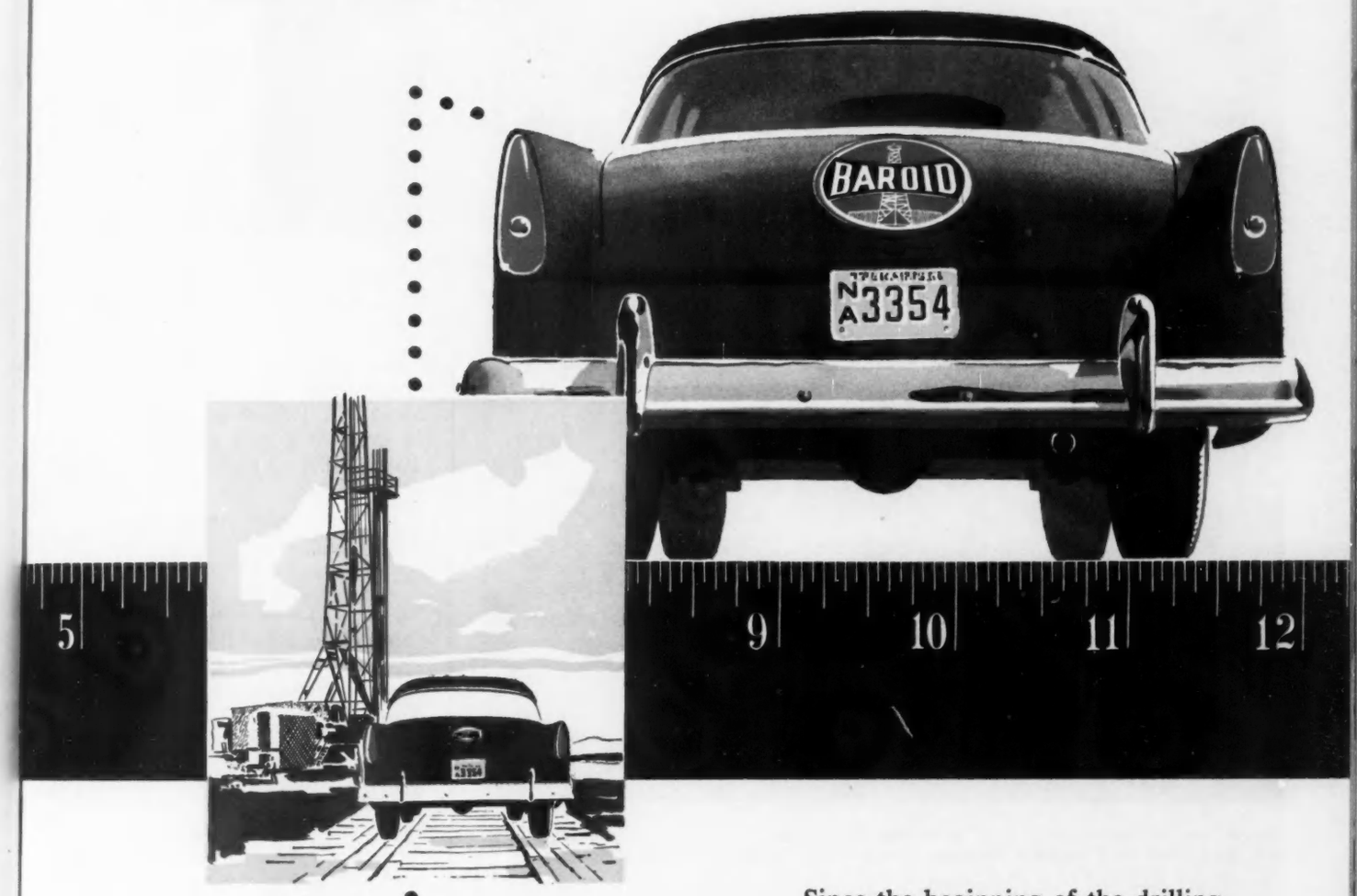

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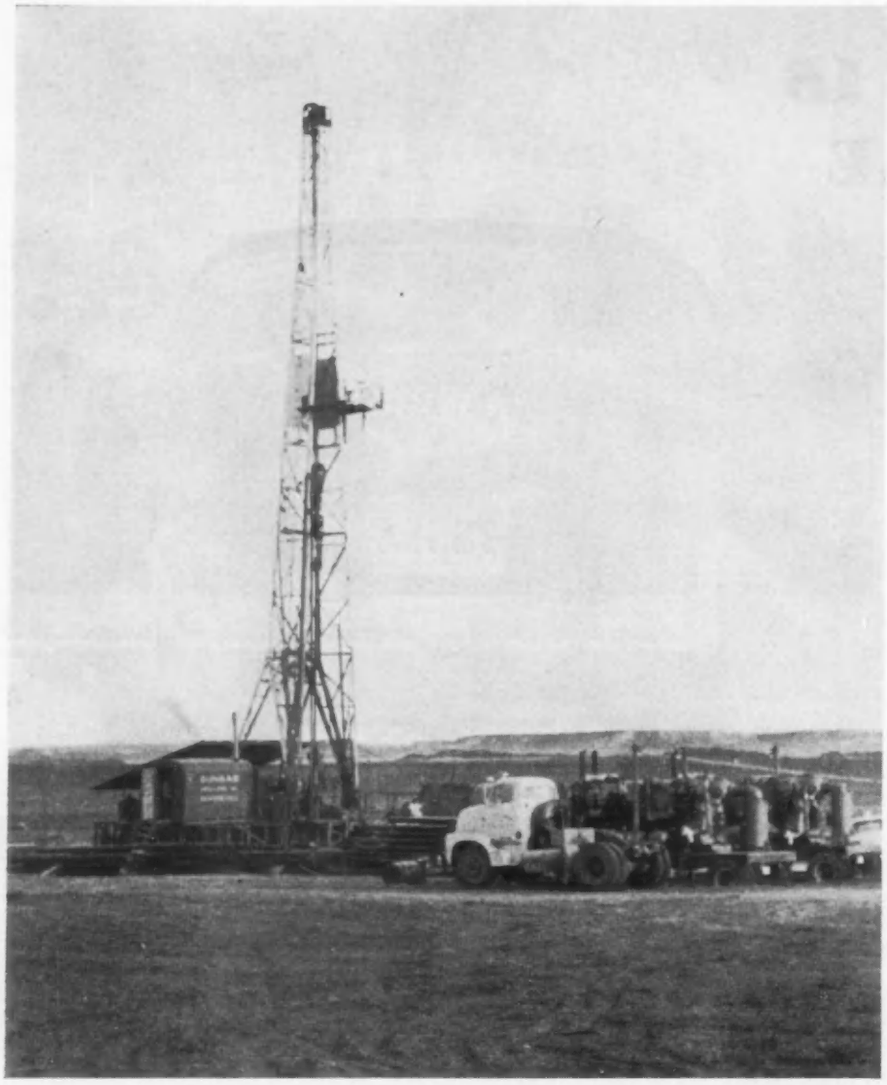

Rig and air drilling equipment used in drilling Government No. 2 and No. 3, in South Little Buck Creek field, Niobrara, Wyoming. Note portable, trailer-mounted air compressors.

The three wells, Continental Oil Company's Government 1, 2 and 3, are situated in Section 2-T35N-R64W and are less than a quarter of a mile apart. The purpose of this article is to present statistical data obtained from these drilling operations, comparing results of the conventionally drilled well with those of the two air-drilled operations. The three wells lend themselves admirably to this purpose as they had the same pay objective, penetrated the same formations and lithology at comparable depths, and are bottomed at the same approximate total depth.

Normal drilling progress curves have been prepared for these three wells (Figure 1). These curves indicate the actual drilling time on bottom, trip time, and normal rig servicing time. These curves do not show time consumed in fishing, logging, circulating mud or other activities that might be peculiar to one well and not to the others.

The 9-inch rock bit that drilled 3876 feet with air circulation for average of 74 feet per rotating hour on bottom. Photograph was taken minutes after the bit was pulled from the well. The bit could have made more hole.

The conventional drilling mud operation, Government 1, required 42.8 over-all days to drill and complete whereas the air drilled wells, Government 2 and 3, required a total of 17.5 and 7.0 over-all days respectively, to

About the Authors

E. A. POLUMBUS, JR. is a consulting petroleum engineer with headquarters in Denver. Prior to entering the consulting field in 1951 he was associated with The Carter Oil Company in various engineering capacities continuously for 18 years. His first work in the oil fields was with Carter in Seminole, Oklahoma in 1928. He has been located in the Rocky Mountain Region for the past 11 years. He is a graduate of Tulsa University with a B.S. degree in engineering. He is vice president of the Denver Petroleum Club.

M. S. LEGGE was graduated from The Texas Technological College in 1942 with a degree in petroleum engineering. From 1942 until the latter part of 1946 he served with the U. S. Navy. He was with the Stanolind Oil and Gas Company in a number of oil fields in New Mexico and West Texas from 1946 until mid-1951, when he entered the graduate school of Colorado School of Mines. Early in 1954 he left graduate school to serve with the Polumbus organization as a petroleum engineer.

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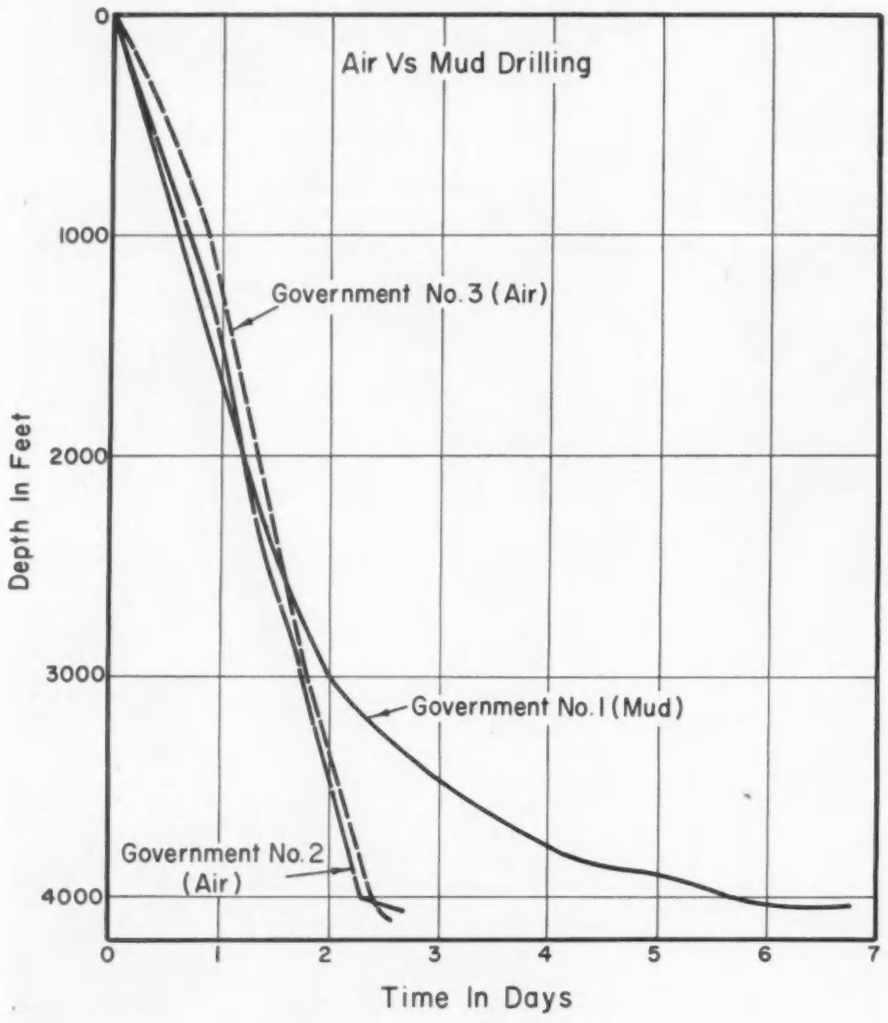

FIGURE 1—Depth vs net rotating time.

TABLE 1

Time Analysis From Spud to Total Depth
Government 1 (Mud-drilled Well)

	Days	Percent
On bottom, normal trips, rig service, etc.	8.6	20.1
Coring and reaming	2.1	4.9
Mechanical downtime	1.1	2.5
Hole condition, mix mud, lost circulation	13.7	32.1
Circulate samples, wait on orders	0.5	1.2
Logging	1.2	2.8
Fishing	1.1	2.5
Drill stem tests	2.8	6.5
Rig up on spud date	0.7	1.6
Casing, reaming, running, W.O.C.	3.7	8.7
Completion	7.3	17.1
Total	42.8	100.0

Time Analysis From Spud to Rig Release
Government 2 (Air-drilled Well)

	Days	Percent
On bottom, normal trips, rig service, etc.	3.0	17.1
Coring and reaming (including trips)	0.4	2.3
Mechanical downtime	0.4	2.3
Hole condition, mix mud	0.8	4.6
Surveys, logging	0.6	3.4
Drill stem tests	0.5	2.9
Wait for rig equipment	0.3	1.7
Rig up on spud date	0.9	5.1
Casing, reaming, running, W.O.C.	3.6	20.6
Recement casing	2.0	11.4
Completion	5.0	28.5
Total	17.5	100.0

Time Analysis From Spud to Rig Release
Government 3 (Air-drilled Well)

	Days	Percent
On bottom, normal trips, rig service, etc.	3.6	51.4
Mechanical downtime	0.5	7.1
Wait on orders	0.5	7.1
Logging	0.2	2.9
Rig up time on spud date	0.6	8.6
Casing, reaming, running, W.O.C.	1.3	18.6
Plug and abandon	0.3	4.3
Total	7.0	100.0

TABLE 2

WELL	Net Days	No. of Rock Bits	Average Feet per Net Day	Average Feet per Rock Bit
Government 1	8.0	8	475	475
Government 2	2.5	1	1568	3876
Government 3	3.1	2	1258	1949

drill and complete. Lost circulation and related downtime items accounted for 13.7 days or 32.1 percent of the over-all time for the Government 1, whereas wells 2 and 3 experienced no downtime due to those problems.

The net drilling days required for these wells were 10.7 for the mud-drilled well, and 3.4 and 4.1 respectively for the 2 and 3 wells. Six and eight tenths actual rotating days were required to total depth for the mud-drilled well, as compared to 2.7 rotating days for each of the air drilling operations.

A time analysis breakdown for each well is presented in Table 1 to provide a basis for comparison of major drilling and downtime items.

TABLE 3—Bit Summary

Bit Size	No. Bits	Footage	No. Hours	Feet/ Hour	Feet/ Bit	Hours on Bot./Bit
Government 1 (Mud-drilled Well):						
Drilling						
12¼	1	207	7.0	29.5	207	7
9	8.2	3801	137.2	27.5	463	16
Reaming						
9	0.8	23	2.2	10.4	28	27
Coring						
6⅛	2	50	19.7	2.5	....	....
Government 2 (Air-drilled Well):						
Drilling						
12¼	1	92	4	23	92	4
9	1	3876	52	74	3876	52
6¾	1	87	4	21	87	4
Reaming						
20	1	92	3	30	92	3
Coring						
6⅛	1	23	5.5	4	....	....
Government 3 (Air-drilled Well):						
Drilling						
9⅞	3	3995	55.2	72	1033	18.4
12¼	1	109	9.0	12	109	9.0
Reaming						
13¾	1	109	2.0	54	109	2.0

NOTE: One 9-inch rock bit used to drill out bridges and condition hole. One 6⅛ rock bit used to drill out plugs in 7-inch casing.

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Table 2 gives data which highlights bit performance characteristics for each of the three wells, from surface pipe to 4000 feet.

A 9-inch rock bit drilled 3876 feet in the air-drilled Government 2 well. When pulled, this bit still was considered "green" and gauge teeth still were fairly sharp. This bit drilled at a rate averaging 74 feet per rotating hour on bottom.

Based on these operations, it is apparent that air drilling showed improved results, in each of several categories, by a factor of three or better.

The bit summary (Table 3) shows the complete breakdown of bit performance for each of the three wells.

In the lost circulation zones of the Government 1 well, large amounts of mud and lost circulation additives were required. A table of the mud required for this drilling operation is shown in Table 4. Each of the two air drilling operations required only small amounts of mud for setting of surface pipe and drilling-in operations. The differences, it will be noted, were great, and accounted for large savings in mud costs in the air operations.

TABLE 4

Mud Additives

(Tabulated From Drilling Reports)

Government 1 (Mud-drilled Well)

Bentonite	308,300 Lbs.
Hulls	31,200 "
Fibertex	28,560 "
Seal Flakes	6,100 "
Tannex	1,770 "
Sementox	800 "
Jel Flakes	850 "
Caustic	630 "
Quebracho	160 "
Soda Ash	150 "
Driscose	50 "
King Seal	206 Bales
Queen Seal	190 "
Palco Wool	28 "
Hay	9 "
Sawdust	145 Sacks
Crude Oil	70 Bbls.

Government 2 (Air-drilled Well)

Drilled with air to 4020 feet.
Drilled with mud 4020-4078 feet.
Added following to 20 bbls of gel mud:

Tannex	3,900 Lbs.
Bentonite	3,900 "
Driscose	100 "
Caustic Soda	50 "

Government 3 (Air-drilled Well)

None.

ACKNOWLEDGMENT

Appreciation is expressed to Continental Oil Company for permission to assemble the data necessary for the preparation of this article. In addition, credit is due Dunbar Drilling Company and Well Completions, Incorporated, for their aid in acquiring basic data.

Rocky Mountain Drilling Practices . . .

Continued from Page 137

with the result that Rocky Mountain rigs are much less elaborate than many rigs in other parts of the country.

Gas and Air Drilling Aid Penetration Rates. Drilling with both air and natural gas has been attempted in the Rocky Mountains with some success. Where gas is available, such as in the San Juan Basin and in the Green River Basin, rates of penetration have been greatly increased with the use of gas as a circulating fluid. The drilling of hard formations is speeded up by as much as 100 to 200 percent by the reduction of the weight of the fluid column, the rapid lifting of cuttings and the high rate of rising velocity around the drilling string. Productivity of the producing formation is no doubt many times improved by the prevention of any wetting of the formation by conventional drilling mud. Drilling with natural gas is not universally used throughout the area because of the general shortage of natural gas in many locations.

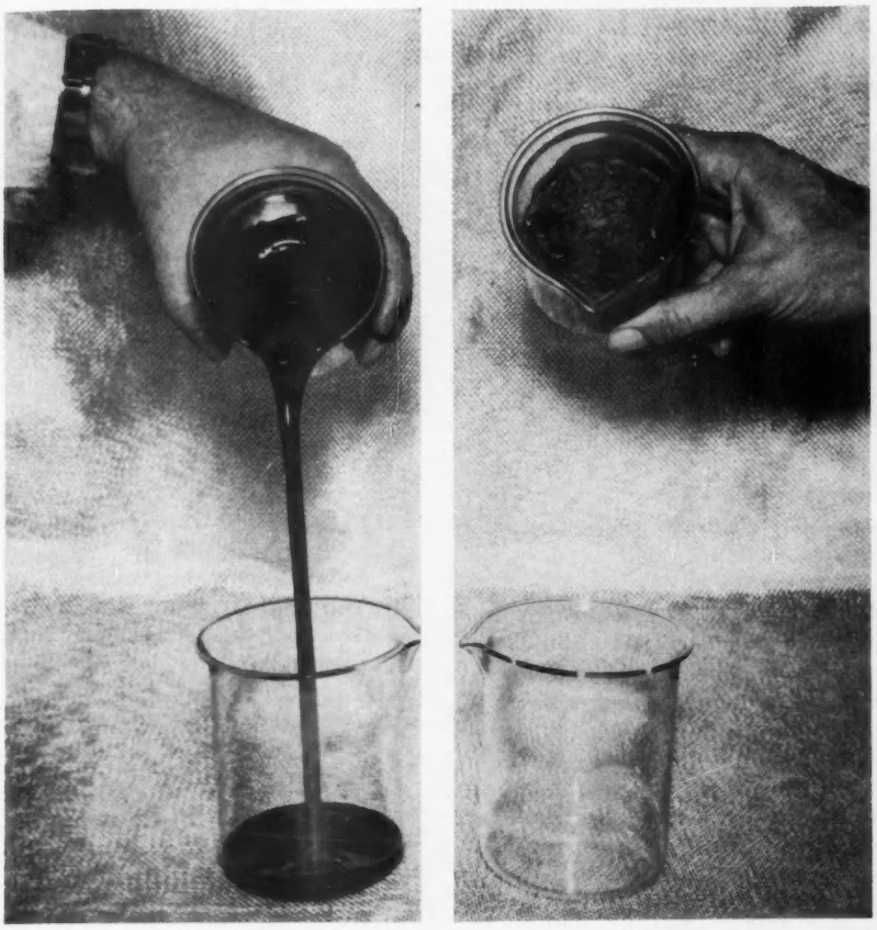
Drilling with air as a circulating fluid has also been used with considerable success. In the Little Buck Creek field of the Powder River Basin, it is reported that one operator drilled 3876 feet with one bit in approximately 52 hours, utilizing air where it had required 7 or 8 bits and more than 15 days with conventional drilling mud. It is possible to obtain air compressors on a rental basis, and more and more air drilling is being attempted each year. Surface water, of course, presents a serious obstacle, but in many cases this is proving to be less serious than was first anticipated. Some tests have been made with the injection of air into the mud stream in order to reduce the weight of the fluid column. Air was injected between the first stage and the second stage of two pumps compounded. The mud column was quite effectively lightened. In areas of lost circulation this may prove to be quite successful although problems of corrosion and pumping operation still offer some objections.

Slim Hole Drilling More Widespread. Slim hole drilling has been attempted with some success in the Rocky Mountains. In North Dakota one operator drilled a series of 6¾-inch holes utilizing a lightweight wheel mounted rig and succeeded in obtaining very low drilling costs. In the Denver-Julesburg Basin, 5⅝-inch hole is being drilled to approximately 4500 feet with considerable success. These are exploratory wells, and it is possible to run electric logs and drill stem tests without difficulty.

In areas where soft drilling is prevalent and where hole diviation is no problem, slim hole drilling offers much promise for reducing drilling costs. However, in Northern Montana and Central Wyoming, slim hole drilling has encountered serious difficulty with crooked hole problems as well as lost circulation. The small diameter drilling string is inclined to be more greatly affected by steeply dipping beds in the hard formation.

Small diameter holes also offer more resistance to the passage of the drilling fluid around the drill collars and tool joints with the result that back pressures are built up on the formation and lost circulation troubles develop. Despite these problems the promise of success with low cost drilling equipment and reduced transportation charges intrigues the drilling operators and every effort is being made to improve slim hole drilling techniques. Wheel mounted rigs are being used more and more each year for shallow rigs drilling conventional size holes such as 7⅞ and 9-inch diameters. It is very likely that further improvements in the mobility of wheel mounted rigs will greatly increase their usage in this area.

In glancing back over the period since the end of World War II, it is apparent that great improvements in drilling operations have been made in all categories of Rocky Mountain drilling. Each year drilling speeds are greatly increased. Wells drilled in many of the oil fields such as Oregon Basin, Elk Basin, etc., used to take 90 to 180 days to drill. Wells now being drilled in the same area are accomplished in one-fourth to one-third of the time. The cost of labor and materials has gone up greatly just as it has in all parts of the country, but the improved techniques and new drilling equipment are making it possible to continually reduce the cost of drilling throughout the Rocky Mountain Area. —**The End**



Freshly prepared and fluid diesel oil cement slurry (shown at left) compared to very thick and paste-like water contacted slurry.

A report to the industry on . . .

Diesel Oil Cement

By CHARLES McLAUGHLIN and WAYNE F. HOWER,
Halliburton Oil Well Cementing Company
Duncan, Okla.

SINCE THE FIRST publications describing field applications of diesel oil cement slurries for squeeze cementing, much valuable experience has been gained.[1,2] One of the main points that was recognized early and further emphasized many times through research and field experience, is the fact that the diesel oil slurry is in no way comparable to the common water slurry.

Squeeze cementing has many times been used in blind attempts to shut off water in oil wells with the hope that a successful job can be immediately attained. Many materials, all having merit, have been presented, but none, including the diesel oil cement slurry, have been found to be the complete answer to the great variety of conditions that exist in the industry.

But, there is one point that cannot be ignored, and that is the fact that it is a costly procedure to produce water with oil and any reduction in water production is a step in the right direction. Since the diesel oil cement slurry has been quite successful and has performed well under very difficult conditions, the slurry and the over-all field results of this now accepted method of shutting off water in oil wells will be discussed here.

Diesel oil cement mixture, usually called DOC, normally consists of dry Portland cement slurried with a solution of diesel oil and a selected surfactant. The solution acts as a carrier for the Portland cement. Kerosine is an acceptable substitute for diesel oil and a few crude oils can also be used to form an efficient slurry. Since no water is in the slurry, special cements are not needed, as the cement starts to set only when the slurry contacts water in the well. The use of admixes in this slurry are usually discouraged as they lend nothing constructive to the mixture and frequently form slurries that have inferior qualities, both for the liquid slurry and the resultant set material.

The role of the surfactant is very important and its selection depends on many factors. It permits the mixing of twice as much cement in the oil thus developing a more concentrated slurry which will give sets of high density and compressive strength. The proper surfactant also causes a more reliable penetration by formation water into the diesel oil slurry, even when no formation differential pressure is tending to force water into the slurry.

The slurry, with the proper surfactant, is like a sponge which will absorb water very efficiently. After penetrating a crevice or fracture, the slurry will thicken rapidly to a paste due to water absorption thus giving some control over the flow of the mixture and greatly reducing the volume of slurry necessary to obtain a satisfactory shut off. Figure 1 shows this great change in slurry viscosity. Such a paste development is not a flash set as more water absorption is required to hydrate and set the cement. This phase also encourages low squeeze pressures thus greatly reducing the possibility of damage to the oil bearing zone.

A feature of this slurry is the fact that it is frequently selective in its

action. Many jobs have been reported where no major recompletion efforts were required to regain oil production. However, there were numerous wells that required reperforating, acidizing, or fracturing to regain communication with the formation. Because of this, considerable research has been undertaken in an effort to improve the performance of this slurry to make it more selective.

Another advantage of this slurry is the fact that the fluid lost to the formation is oil, which is not capable of water blocking the formation. The fluid loss of the slurry will vary some for different Portland cements but it has been found to be generally much lower than for the normal water slurry. Filter cakes so developed remain soft and can be washed out of the hole with oil unless contacted with water. The water contacted filter cake is very stiff and it, in conjunction with the above described thickening of the slurry with water, are the main factors in the control of the slurry and resulting squeeze pressures.

Although the cost of this slurry is greater than a water slurry when compared on an equal volume basis, it is usually much cheaper to use due to a smaller volume being required and less expense for recompletion after the squeeze. The compressive strength of the set diesel oil cement slurry is very good. Recent tests made with Portland cement, mixed in the ratio of 4 gallons diesel oil to 1 sack of cement and squeezed under 5 pounds per square inch differential pressure, gave the following compressive strengths:

	78° F	140° F
1 day	4230 psi	7300 psi
4 day	6830 psi	8300 psi
7 day	9850 psi	10900 psi

Water production in an oil well can arise in a number of ways. The most common causes probably are: Mistakes during the completing of the well, rise of the water table or coning, fracturing into water, and channel conditions. Some of these sources are fairly easily cured but others are very difficult. In some cases, a series of unfortunate decisions or circumstances will get a well into such condition that a successful treatment is almost impossible. There are also some formations that produce oil and water from the same flow channels which makes it impossible to shut off the water without shutting off the oil.

A survey of the diesel oil cement treatments made in 1954, and reported from most of the oil producing areas in the U. S., provides very interesting and informative data. Although it does not cover all the wells that were treated, it is a good cross-section of the jobs that have been performed. For various reasons many successful treatments were not reported and therefore, are not included in this survey. On the other hand, information concerning an unsuccessful application is sometimes almost impulsively reported.

A successful treatment can be measured in a number of ways. There are those who will consider only an immediate economical improvement a success while others are content with knowledge gained by the treatment so that future work on the well can be more intelligently planned. In the following summary, a successful treatment was defined as one where an economic improvement of considerable value was obtained or where it was proven that no oil production existed in that particular horizon.

It must also be remembered that some applications were considered failures although everyone concerned held little hope for the success of the squeeze before it was attempted. As an example for further clarification: Let us consider a well producing 10 barrels oil per day and 100 barrels of water per day before squeezing with diesel oil cement. Records show the following production rates to be possible as a result of diesel oil cement squeezes.

1. 10 BOPD and 0 BWPD.
2. 100 BOPD and 0 BWPD.
3. 100 BOPD and 100 BWPD.
4. 8 BOPD and 0 BWPD.
5. 8 BOPD and 8 BWPD.
6. 10 BOPD and 50 BWPD.
7. 0 BOPD and 0 BWPD.
8. 0 BOPD and 50 BWPD.
9. 10 BOPD and 100 BWPD.
10. 10 BOPD and 200 BWPD.

The first case could be called the theoretical result. However, there are many reports showing results similar to Case 2. It is felt that Cases 1 through 6 are economically successful with room for some discussion in Case 6. Case 7 may not all be lost but it could be the condition where oil and water are being produced from the same flow channels. However, wise methods of recompletion may give favorable results. The last three cases are possible and are considered failures with the last example being very rare.

The aggregate performance, regardless of the method of completing the wells and the type of formation under consideration, showed the success rate for diesel oil cement squeezing to be 64.5 percent. Breaking this figure down to cover method of completion, it was found that 68.6 percent of the wells treated through perforations were successful as compared to 55.4 percent for open hole completions. This last figure, although relatively low, is very encouraging as the use of water slurries in open hole had a very slim chance of success with the possibility of oil production being drastically reduced. Other interesting facts are as follows:

46.1 percent of the wells treated received some type of post treatment. It was further determined that this treatment was not necessary in many cases.

63.9 percent of the above post treatments helped oil production.

75.6 percent of all treatments shut off the water satisfactorily.

43.1 percent of all treatments shut off water completely. These are included in the above percentage.

56.7 percent of all treatments actually increased the production of oil. In over 50 percent of these cases, the increase in production was not due to post treatment.

25.1 percent of all treatments showed no change in oil production.

18.3 percent of all treatments showed a decrease in oil production which does not preclude success, especially where water production was decreased to a greater extent.

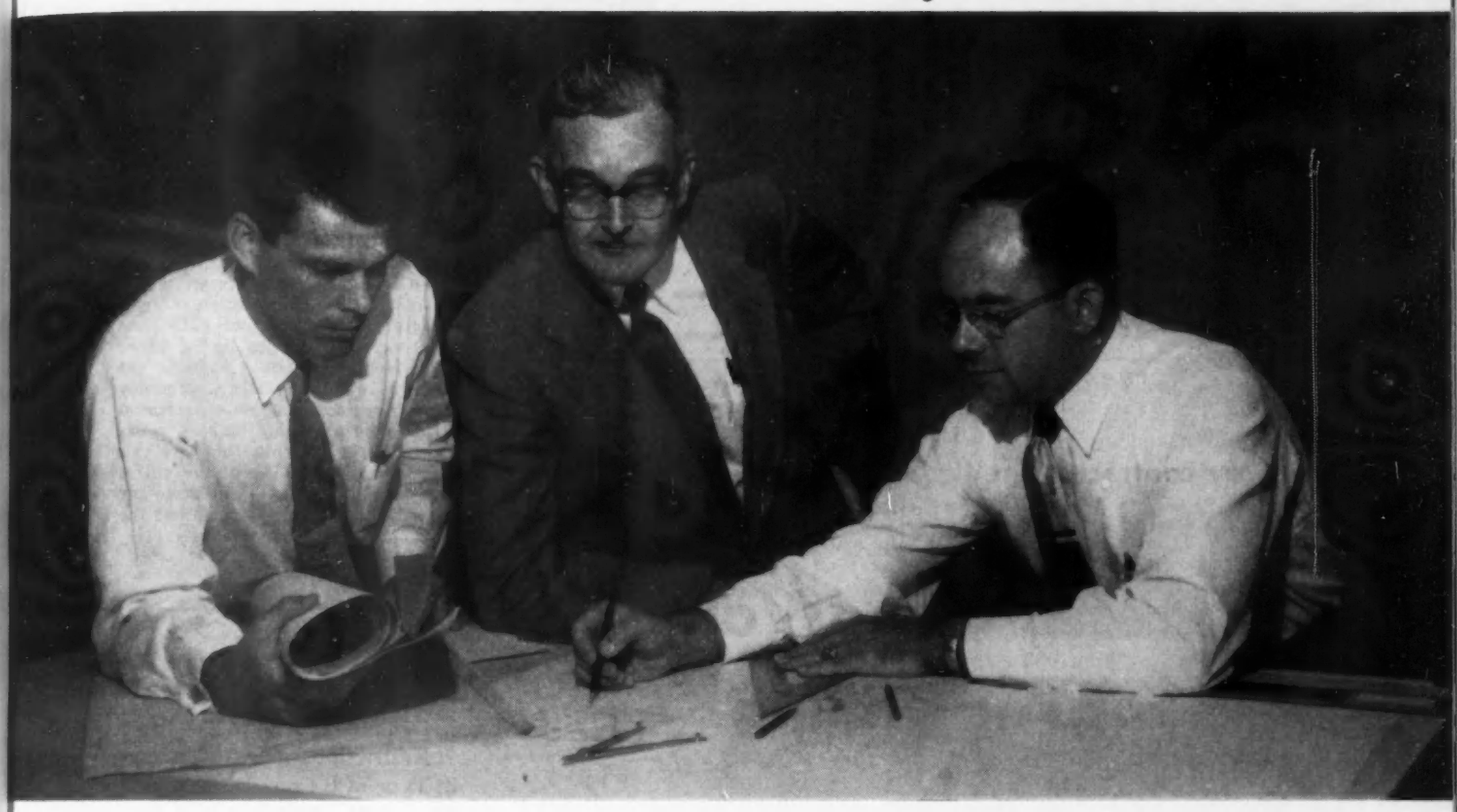
20.0 percent of all treatment were performed on wells producing no oil.

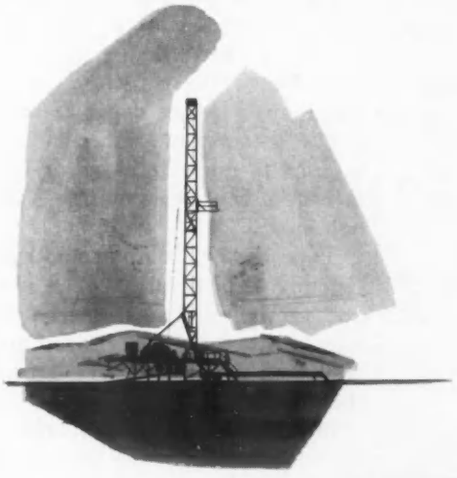
54.5 percent of the treatments performed on wells that were producing no oil were made into good oil producers.

In this analysis of the reported results, the producing formations are classified as sand, limestone and dolomite, and conglomerate. The above percentages can be broken down according to the type of producing for-

Continued on Page 164

It takes a certain kind of specialist...





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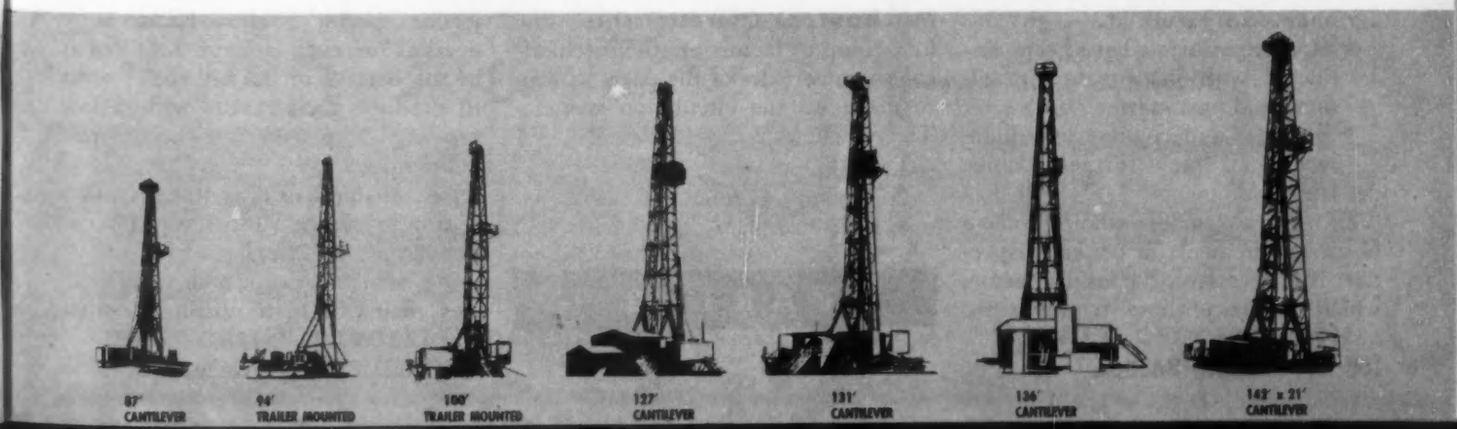

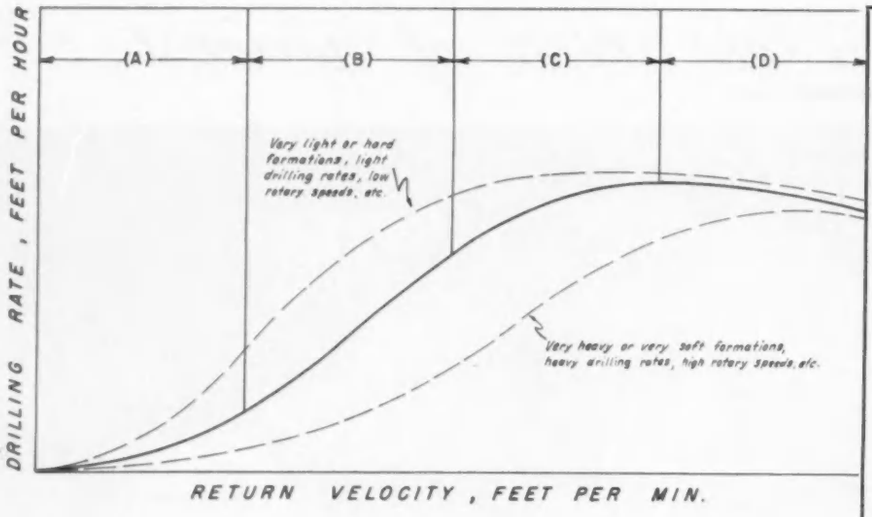
(A)
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(C)
(D)
Very light or hard formations, light drilling rates, low rotary speeds, etc.
Very heavy or very soft formations, heavy drilling rates, high rotary speeds, etc.
DRILLING RATE, FEET PER HOUR
RETURN VELOCITY, FEET PER MIN.

FIGURE 1

A hypothetical return-velocity-penetration-rate curve showing how penetration rate may actually be affected by return velocity. (A) is the range of inadequate return velocity. Some authorities say velocities below 2,000 feet per minute fall in this range. (B) is the range where good results may be obtained, depending on many factors. Various authorities place this range at from 2,000 feet per minute to 6,000 feet per minute or more.[2, 3, 4] (C) is the range where drilling rates may continue to increase, but at a slower rate than compressor costs and the cost of drill pipe erosion. Various authorities place this range at from 3,000 feet per minute up to above 8,000 feet per minute. (D) is the range in which drilling rate may actually decrease because of increased bottom hole pressure. There is no experimental evidence as to where this range might start. The dotted curves show how different variables may change the shape of the curve and the optimum return velocities.

What every contractor should know about . . .

Air Pressure and Volume For Air Drilling

Are you sacrificing drilling efficiency by improper selection of drill pipe, drill collars, and bit nozzles?

By JAMES T. MORRIS, Morris and Company, Houston
and **ROBERT P. RAMSEY,** The Cooper-Bessemer Corporation, Mt. Vernon, Ohio

ONE OF THE toughest questions a drilling contractor must answer when he decides to take advantage of the many benefits air drilling offers is, "How much air pressure and volume should I have?"

Any study of the question will bring into sharp focus three conditions:

- There is no clearly defined minimum. (See Figure 1).
- Most experiments have been conducted with inadequate air volumes and pressures.
- New bits and changes in drilling techniques may further change the requirements.

In order to put the whole problem of air requirements in better perspective, it is necessary to consider factors which influence those requirements. Those factors are:

Mechanical characteristics.
Formation characteristics.
Drilling techniques.
Water conditions.

The effect of each of these group of factors on air volume and pressure requirements will be discussed.

Mechanical Characteristics. The first group of factors are the mechanical characteristics of the parts that go to make up the circulation system. These include:

1. Drill pipe size.
2. Type of tool joint.
3. Hole size.
4. Smoothness of hole.
5. Drill collar size.
6. Drill collar length.
7. Restrictions in surface lines.
8. Type of bit nozzle.

The drill pipe size and hole size control the area of the annulus and therefore control the basic volume requirements. These factors are generally limited by the depth of hole and required casing program. Table 2 can be used to estimate basic air requirements for the different pipe sizes and hole sizes.

Type of tool joints, smoothness of the hole drilled, drill collar size (ID and OD) and drill collar length, all affect both the pressure drop and the ability of the air to carry cuttings to the surface.

Little is known about the exact effect of each of these factors except to say that, at present, the system should be designed for as few restrictions as possible.

For straight air drilling, there seems to be no advantage to using jet or special nozzles. Extra large nozzles (or even a large hole bored in the bottom of the bit body) seem to produce good results with a low pressure drop and low horsepower consumption.

For air-mud drilling, the situation is not so clear. Most successful experience to date has been with jet bits using small nozzles. These small nozzles maintain high nozzle velocities

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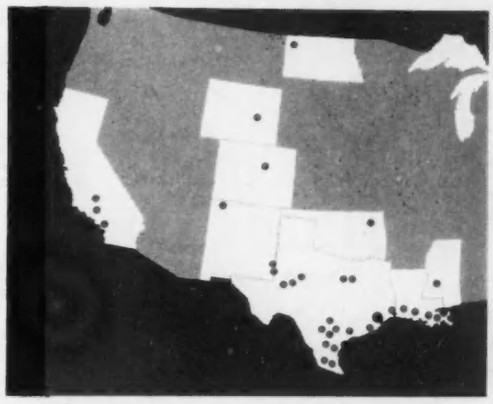

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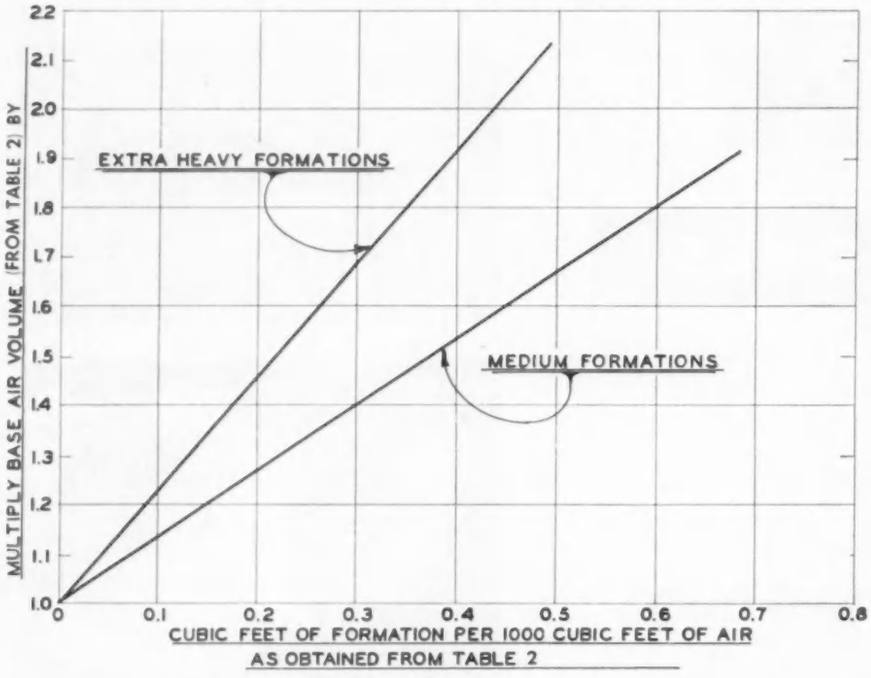


FIGURE 2—This chart can be used to approximate the added air requirements for extra fast drilling or the drilling of extra heavy formations. This chart is based on changes in the density and velocity of the mixture only. Other variables are not considered.

with the restricted mud volumes and the relatively high bottom hole pressures encountered. However, as greater air volumes and even smaller mud volumes are used, bottom hole conditions more closely approach those of straight air drilling. It remains to be seen what nozzle designs will be most satisfactory for air-mud drilling.

Formation Characteristics. Formation weight influences the required return velocity. While 3000 feet per minute may be adequate for many formations of average specific gravity, heavy formations (such as iron ore) may require much higher velocities.

From a practical standpoint it will probably be expedient to rent added compressor capacity or go to reverse circulation or mud drilling when extremely heavy formations are encountered.

The drilling rate may affect air requirements under certain conditions. Here is an example: When drilling 8¾-inch hole with 4½-inch drill pipe, about 1000 cfm of air is required to maintain a 3000 foot-per-minute return velocity. This means that about 70 pounds of air per minute will be used. If the penetration rate is 10 feet per hour and the specific gravity of the formation is 2.5, cuttings will be produced at the rate of 11 pounds per minute. This will increase the density of the air by about fifteen percent and decrease the return velocity to about 2600 feet per minute.

Since lifting power of the air is proportional to the density and the square of the velocity,[2] about 10 percent more air is required to maintain the 3000 feet per minute lifting capacity (See Figure 2).

If the penetration rate is 100 feet per hour, cuttings would amount to nearly 110 pounds per minute. The weight of the stream of air and cuttings would be about 180 pounds per minute. The lifting power of the stream would be reduced to about four-tenths normal, so a substantial increase in air volume is needed. The graph in Figure 2 indicates that return air velocities of about 5500 feet per minute should be tried.

In practice, it may not be economical to provide enough air for extremely high drilling rates. Instead, drilling weights or rotary speeds may be reduced in order to reduce the rate at which cuttings are produced.

Another formation characteristic which may influence the air volumes required is what might be called "shatterability." Laboratory tests by bit manufacturers indicate that many formations tend to shatter under the tooth action of the bit—producing a high percentage of very fine cuttings. Where this is the case, less air will be required than in the case of formations which tend to break up into larger cuttings.

Much more research must be conducted before definite conclusions can be reached concerning the effect of average cutting size on air volume requirements. Preliminary tests indicate that air volume requirements may need to be increased to support the larger cuttings of the softer formations.

Drilling Techniques. Drilling rate, size of cuttings and volume of cuttings can be varied over wide limits by simply altering drilling techniques and bit selection.

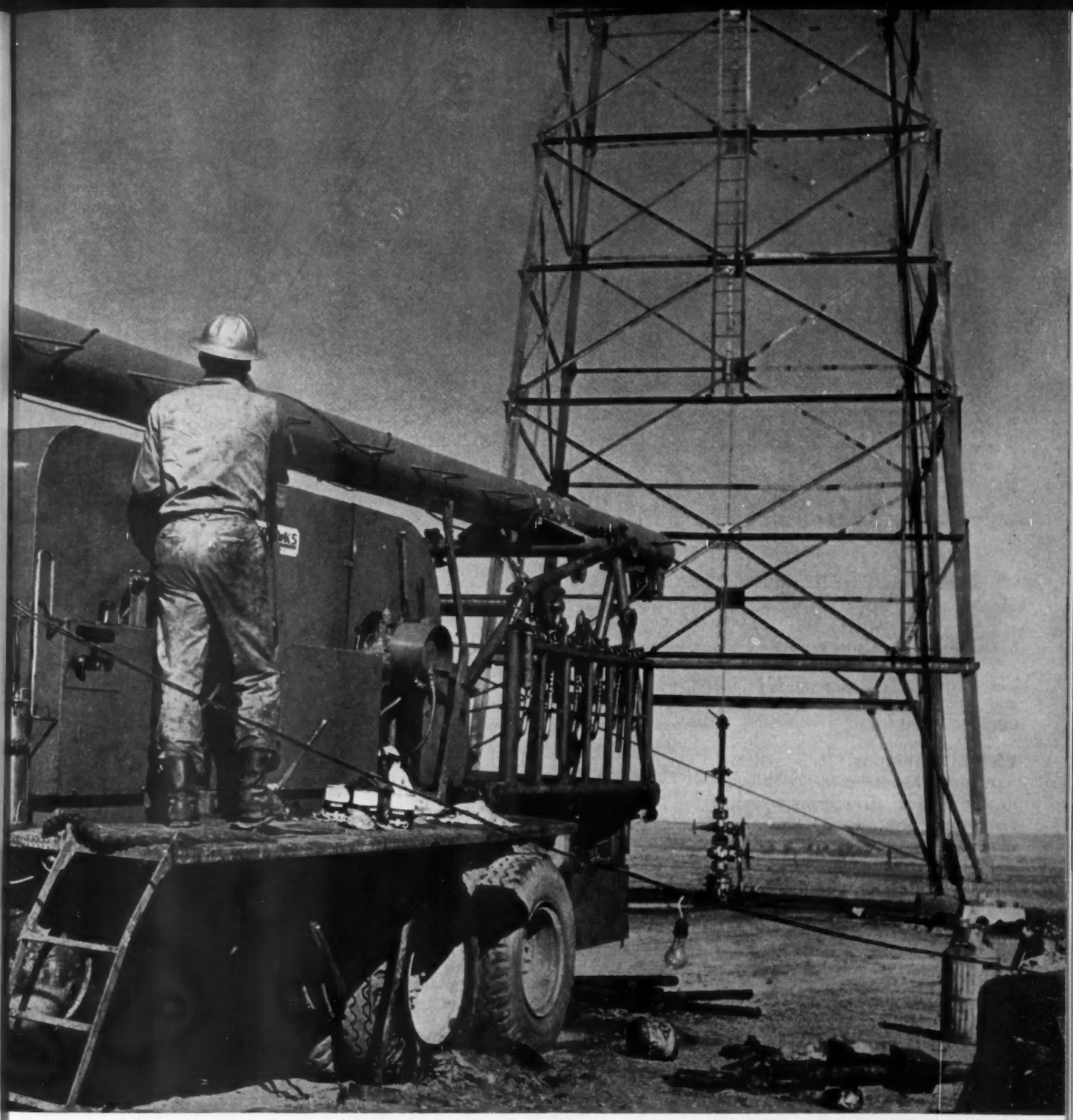
Bit tooth design, for example, exerts a powerful influence on size of cuttings. Many operators have practiced using fine-tooth bits in order to produce smaller cuttings that are more easily removed. Much more experience is needed before firm conclusions can be drawn about the relation between tooth design, penetration rate, footage per bit and air requirements.

Weight on bit has had a profound effect on penetration rate and bit life in the case of mud drilling. Some operators have achieved outstanding results by using weights as high as 100,000 pounds on 8¾-inch bits when using mud as a circulating medium.

Experience to date fails to show a similar advantage for heavy weights in air or air-mud drilling. Some operators believe, however, that the benefits might show up when more air volume is provided to remove the greater volume of cuttings.

Present experience indicates that a return velocity of 3000 feet per minute is adequate for air drilling of normal to hard formations unless water is encountered. However, an operator must consider the possibility that new bits and new techniques may increase air requirements.

Rotary speed affects penetration rate and bit bearing life as well as the volume of cuttings to be removed. These relationships are fairly well established in the case of mud drilling but much study still needs to be done in the case of air or air-mud drilling. However, the extremely long runs turned in by many bits indicate that higher rotary speeds might be used for faster penetration if sufficient air is available. Only experience can show the optimum rotary-speed-weight-on-bit combinations for air



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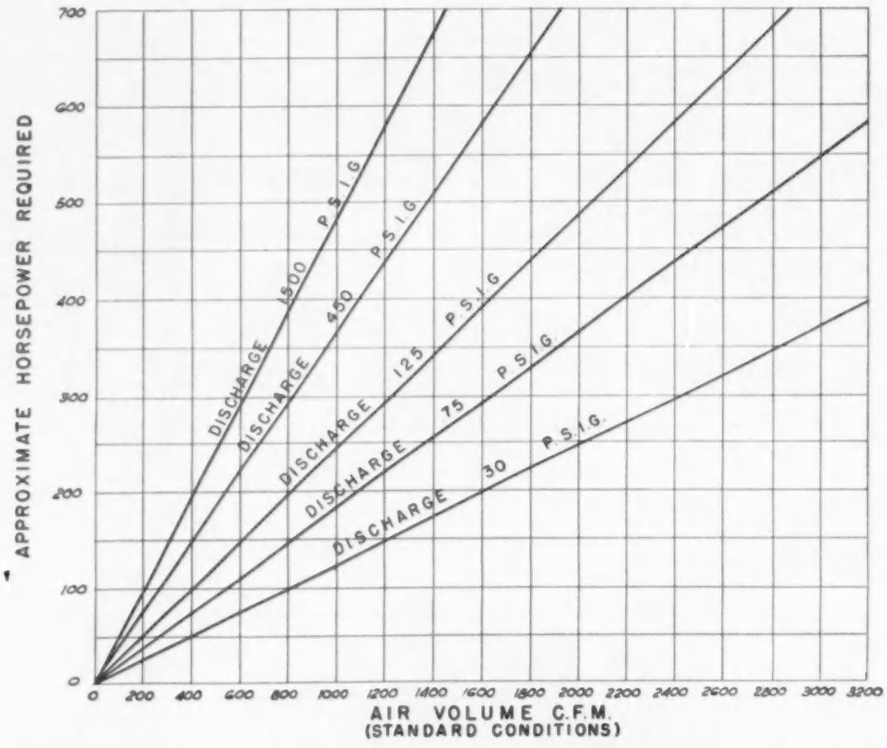

FIGURE 3—This chart gives approximate gross horsepower requirements for compressor systems at different air volumes and different discharge pressures.

and air-mud drilling of various formations.

Water Conditions. It is generally recognized that the presence of water in the return air stream increases compressor pressure and horsepower requirements very definitely. In the case of water zones encountered during air drilling, the pressure increase is most severe since the compressors must supply full bottom hole pressures plus frictional losses through the drill pipe. Relatively small water flows of less than 100 gallons per minute can boost pressure requirements to 1000 psi under certain conditions.

Some operators have found that they can handle water more effectively if they double or triple the volume of air over that required for dry drilling. This will have the effect of reducing steady state pressure requirements and should speed up drilling.

Corrosion problems and salt water disposal problems, as well as compressor requirements, will rule out the use of air when drilling through highly productive water zones. However, some extra compressor pressure is necessary to handle water zones of low productivity.

The static water level is occasionally the deciding factor as to whether air can be used because water will exert a pressure of about ½ psi per foot of depth.

For example, if a water zone is encountered at 6000 feet and the level rises 4000 feet while a round trip is being made, the air pressure required to blow out the hole in one step would be over 2000 psi. Theoretically, it would be possible to blow out the hole by stages with lower pressures if the zone was not producing very fast. In most cases, however, the rate of production would make such a practice impractical or impossible.

With air-mud drilling, pressure requirements in the case of water production are less severe than with air, because the weight of the mud column helps to balance bottom hole pressure.

One leading exponent of air-mud drilling[1] has estimated that a compressor pressure of 1500 psi may be needed for rapid unloading of the mud column and steady state pressures of 400-500 psi may be encountered.

In practice, these pressure requirements may be reduced by the use of larger air volumes, smaller mud volumes or low-pressure-drop bit nozzles. Pressures can be expected to rise if a water zone is encountered however, so it is probably important to provide the pressures recommended.

How to Determine Air Requirements. The two examples that follow have been chosen to illustrate conditions that might be encountered in air or air-mud drilling. They show where the critical compressor requirements fall and illustrate certain desirable compressor characteristics. They are not intended to be representative of any special rigs or any specific drilling programs.

Example 1

Total rated rig horsepower.....800
Actual rig horsepower available for compressor at takeoff.....500
Hole sizes:

15½	inch to	500 feet
11	inch to	3,000 feet
7⅞	inch to	9,000 feet
4¾	inch to	11,000 feet

Drill pipe program:

6⅝	inch to	500 feet
4½	inch to	9,000 feet
2⅞	inch to	T.D.

For the 15½-inch hole it is expected that a water sand will be encountered at 375 feet and water will be used for drilling from 375 feet to 500 feet. Air will be used from surface to 375 feet.

By consulting Table 2, the air volume requirement for a return velocity of 3000 feet per minute is found to be 3210 cfm. Since no effort will be made to drill with air through wet formations, and since bits with large water courses are to be used, it is believed that pressure requirements can be held to 30 psig. The horsepower requirements for 3210 cfm at 30 psig (from Figure 2) appears to be 380 horsepower—well below the available horsepower.

However, if piston compressors are used, it may not be practical to provide that much volume, so two alternatives may be tried.

1. A return to 2000 feet per minute could be tried. This would require a volume of ⅔ of 3210 or 2140 cfm.
2. Reverse circulation may be used. From Table 2, the volume requirements for 3000 feet per minute return velocity up the drill pipe is found to be 600 cfm. From Figure 3, it is found that the horsepower requirement will be about 70. Since available air volumes will be far in excess of this, we can be sure of successful drilling unless caverns are encountered.

For the 11-inch hole, it is expected that air will be used to 2700 feet where a water sand will be encoun-

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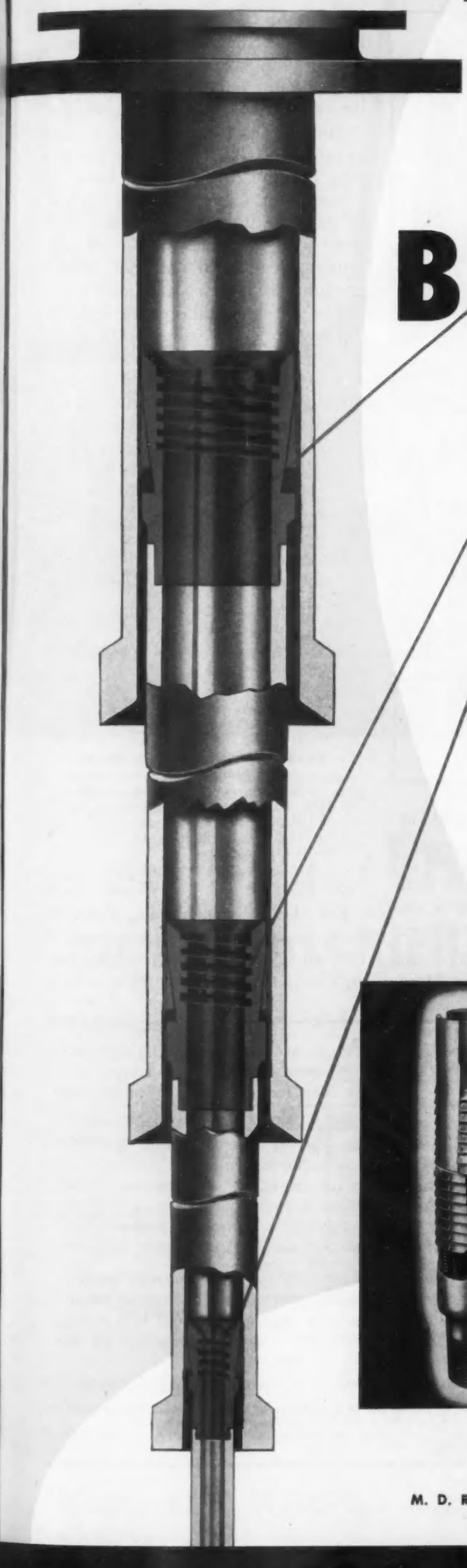

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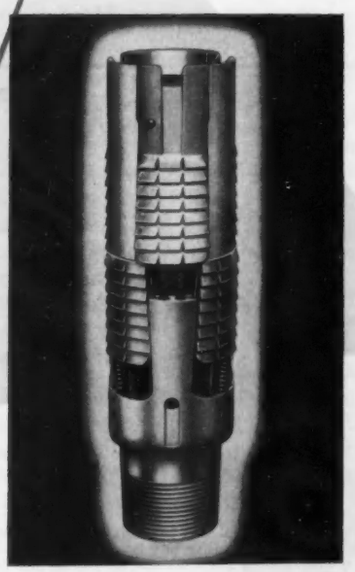

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About the Authors

ROBERT P. RAMSEY is a recognized authority in industrial market research and product design. Graduating from M.I.T. in 1922, he became a sales engineer for the Atlas Engine Company. In 1928 he was made chief engineer of Buda Company's Diesel Division. In 1934 he became chief engineer for the Superior Engine Company and later executive engineer for the National Supply Company. At the outbreak of World War II, he went to the General Machinery Corporation, now the Lima-Hamilton Corporation, as chief engineer of research and later vice president of engineering. He is now director of market research with The Cooper-Bessemer Corporation, Mount Vernon, Ohio.

JAMES T. MORRIS graduated from the University of Texas with a B.S. degree in mechanical engineering. After employment as a design engineer for an oil tool manufacturer, he served for 15 years as account executive and director of research for Brennan Advertising Agency, Houston, servicing oil equipment manufacturers. At present he is the owner of Morris and Company, specialists in drilling and production market research.

tered. Water or mud will be used for the remaining 300 feet.

From Table 2, the volume requirement for a return velocity of 3000 feet per minute in 11-inch hole with 4½-inch drill pipe is found to be 1645 cfm.

Because of the depth of the hole and size of drill pipe, pressures of more than 30 psig are expected. However, from Figure 3, it is found that 1645 cfm at 125 psig or 2200 cfm at 75 psig can be provided with less than 400 horsepower.

Since the depth is less than 3000 feet, no correction due to friction is indicated, so it appears that return velocities of more than 4000 feet per minute could be provided with the 500 available horsepower.

For the 7⅞-inch hole, air-mud drilling is selected because it gives greater pressure control and makes hole conditioning possible. The peak air pressure-volume requirement will be at the bottom of the hole.

To date, no experimental data have been obtained at these depths with desirable air-mud ratios. However, calculations made by Bobo et al[1] indicate that volumes of 1400 cfm at pressures of 300-500 psig may be required. The chart of Figure 3 indicates that this volume can be obtained with less than 500 horsepower.

Desirable starting pressures and volumes are less clearly defined. However, if the full available horsepower is used, the compressor system should deliver more than 1000 cfm at 1500 psig. Experimental evidence indicates that this will be more than adequate.

For the 4¾-inch hole, the volume requirements from Table 2 is 235 cfm. Because of the depth, however, a correction factor must be applied. By adding 20 percent for each 2000 feet of depth below 2000 feet (approximate addition for small holes), a volume of 535 cfm is indicated.

The largest volume requirement in this case, however, would occur at the bottom of the cased 7⅞-inch hole. The largest casing likely to be used would be 5½-inch, so by taking the volume requirement for 5⅝-inch hole and 2⅞-inch drill string from Table 2, and adding 20 percent for each 2000 feet below 2000 feet, the estimated volume requirement at 9000 feet would be 724 cfm.

Closer calculations could be made by consulting published charts,[4] but since the compressor capacity is 1000 cfm at 450 psig, it is obvious that plenty of air is available to maintain equivalent return velocities well in excess of 3000 feet per minute.

Example 2

Total rated rig horsepower..400
Actual rig horsepower available for compressor at takeoff 250
Hole sizes:
12¼ inch to 1500 feet
7⅞ inch to 5000 feet
Drill pipe program:
5½ inch for 12¼-inch hole
3½ inch for 7⅞-inch hole

For the 12¼-inch hole, Table 2 gives an air volume requirement of 1960 cfm. A 250 horsepower compressor could supply about 2100 cfm at

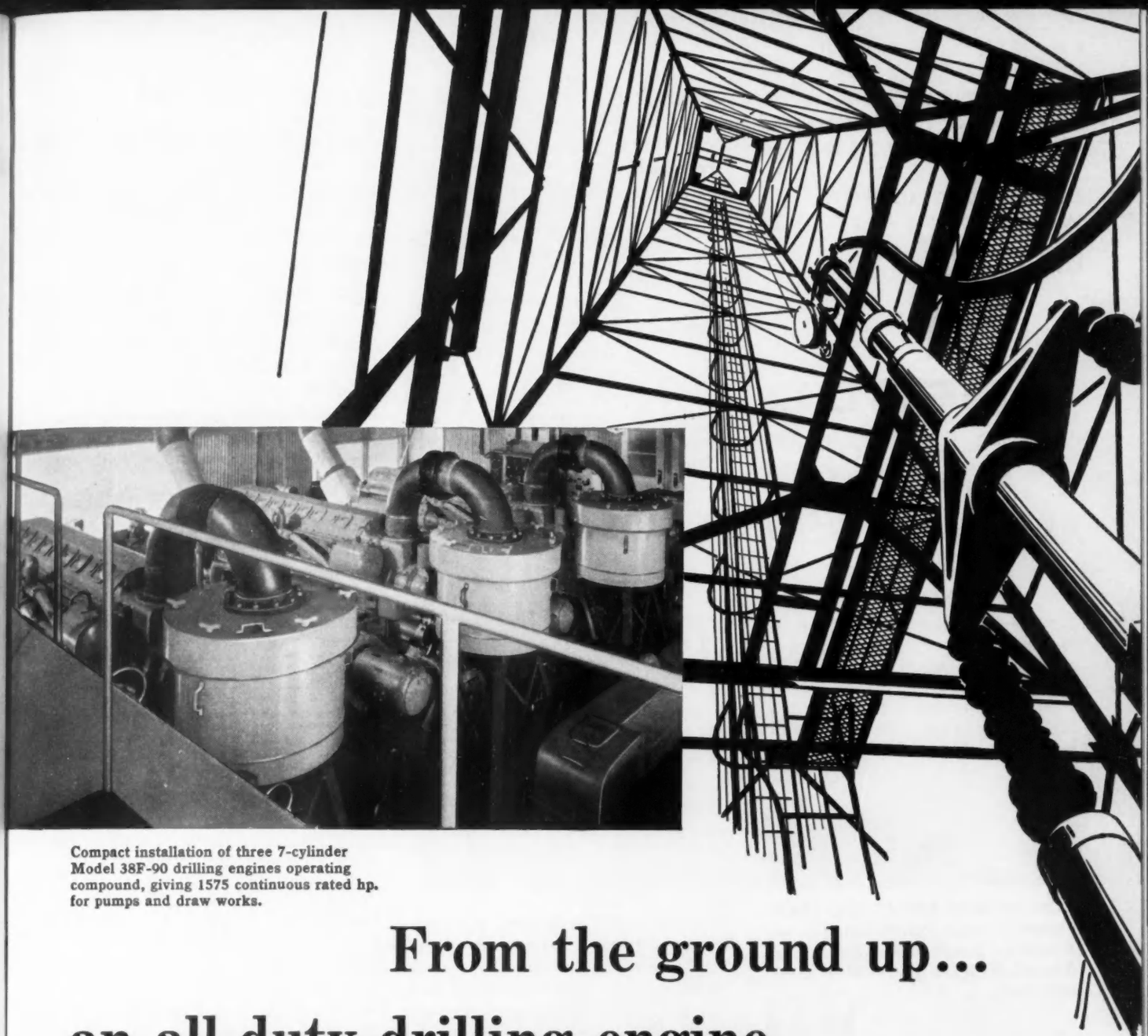
TABLE 2

Hole Diameter, Inches	O.D. DRILL PIPE, INCHES					
	2⅞	3½	4½	5½	6⅝	
4¾	235					
5⅝	380	320				Add 20 percent for each 2000 feet depth below 2000 feet*
6¼	510	440	305			
7⅞		815	680	520		
8¾		1165	920	755		Add 10 percent for each 2000 feet depth below 2000 feet*
9⅝			1190	1025	800	
11			1645	1485	1260	
12¼			2450	1960	1730	Add 5 percent for each 2000 feet depth below 2000 feet*
15½				3420	3210	
For Reverse Circulation			260	410	600	

Calculated air volume requirements for a return velocity of 3000 feet per minute neglecting the effect of friction. This figure may be used for depths of less than 2500 feet.

* The added volume required due to the effect of friction may be approximated by adding a percentage for each 2000 feet increase in depth. If greater accuracy is desired, a major bit or tool joint manufacturer may be consulted.

If different return velocities are desired, the required volume may be approximated by multiplying the figure obtained from this table by the desired velocity and dividing by 3000.



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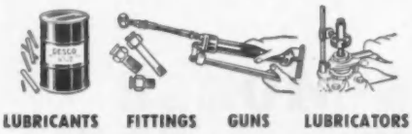

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30 psig. If higher pressures are required, the compressor could supply about 1400 cfm at 75 psig for a return velocity of 2140 feet per minute. Since this would be in excess of the 2000 feet per minute minimum return velocity, satisfactory drilling progress might be maintained unless water is encountered.

If water is encountered, reverse circulation might permit continued drilling for a short time because a 250 horsepower compressor could supply 700 cfm at 450 psig. Success would depend on the quantity of water produced.

For the 7⅞-inch hole, air requirements would be 815 cfm. At a depth of 5000 feet, the requirement might be 950 cfm. Since a 250-horsepower compressor can be expected to deliver over 1000 cfm at 125 psig, it is possible that satisfactory drilling progress might be maintained.

It is doubtful whether really satisfactory air-mud drilling conditions could be established under the conditions mentioned.

It is easy to see that a 250-hp compressor system would barely be adequate for the conditions encountered in standard drilling. A slim hole program would be indicated to give a factor of safety needed to handle water or mud or special formations. Possibly an auxiliary, self-powered compressor or booster might be used in addition to the main compressor system.

Conclusions. It is obvious that there is no such thing as a compressor system that will fit all rigs and meet all the conditions encountered in air and air-mud drilling. Each system must be a compromise selected to meet those conditions considered most important by the contractor and producer.

Economics plays a vital part in making this compromise, so the last paper in this series will consider the economics of using air compressors on a drilling rig.

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To Be Continued

A Report on Diesel Oil Cement

Continued from Page 154

mation but inclusion of all of the data would be too detailed and cumbersome. Table 1 lists some of the more interesting information according to the type of formation treated.

In the applications where water was shut off satisfactorily, recompletion methods sometimes regained water production which caused the percentage of successful jobs to be lower than the percentage where water was shut off satisfactorily.

Open-hole completions in sand formations compare very favorably with perforated casing. Over-all figures show 66.7 percent successful for open hole and 69.5 percent for perforated casing. The results for limestone and dolomite completions are quite different with 66.0 percent successful in perforations and only 43.8 percent successful in open hole. This low percentage is primarily due to one area where oil and water were being produced through the same flow channels.

The above data was accurate at the time of the survey.

However, the development of new and improved techniques in the past few months has made the process more selective which means less expense to the operator for recompletion. This includes the use of diesel oil cement slurries in combination with other proven chemical and physical processes. Research is continuing in an effort to make the process still more reliable and more attractive economically to all concerned.

TABLE 1

	Sand	Limestone and Dolomite	Conglomerate
Successful Squeezes	66.0%	59.5%	77.8%
Squeezes with Water Shut Off Satisfactorily	77.9%	70.6%	85.2%
Squeezes with Oil Production Increased	59.1%	56.5%	56.0%
Squeezes with Oil Production Unaltered	22.8%	26.1%	16.0%

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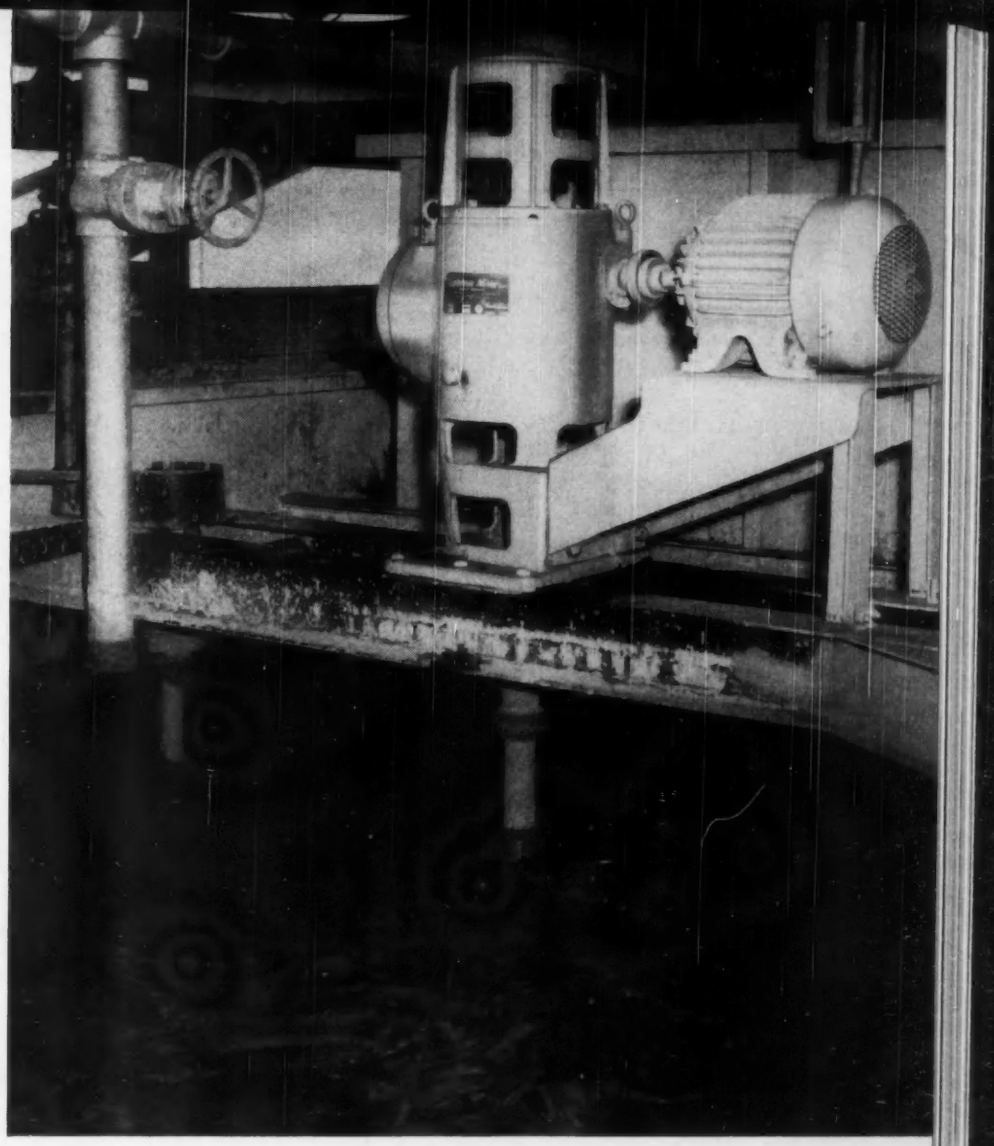
—The End

Why the mud's **always good** *off the Gulf Coast*



There's a powerful difference between ordinary drilling mud and this mud you're looking at, in the tank of an LST drilling barge off Galveston Bay.

This mud has waves in it.

And under the waves, where it counts, this mud flows and interchanges constantly. A strong, steady flow sweeps every corner of the tank—keeping *all* the mud equalized, *all* of it ready for immediate use down the hole.

Mud can't settle out; so less mud is used. The mud bill is much lower than when mud is mixed the old way.

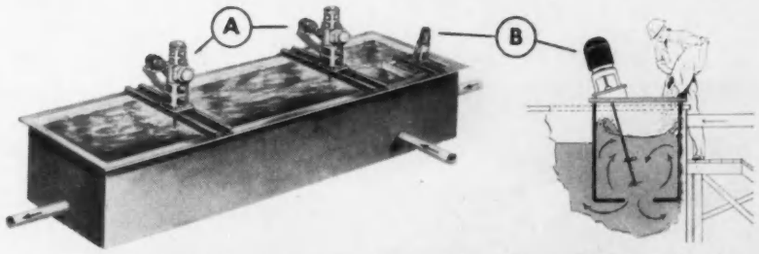
Heavier or thicker mud—in seconds— Every gallon of mud in this system is the same weight and viscosity. And you can *change* mud weight and viscosity, as much or as little as you want, literally *in seconds.*

In an emergency, you can feed-in weight and gel additions by the whole sackful—one sackful right after another. There's no clogging, no waiting. *Immediately*, the whole system shows a uniform weight rise. Within a few minutes, weight and viscosity are completely equalized.

You get this always-flowing, top-condition mud with LIGHTNIN Mixers. First, a high-speed LIGHTNIN Flash Mixer wets and feeds ingredients to the flowing mud—as fast as you can dump them in. Meanwhile, the big LIGHTNIN Mud Mixer you see here distributes the materials evenly—keeps mud fluid and ready to go to work.

Make savings like these—You actually *save* on power, because you need not use a standby pump for tank circulation. The LIGHTNINS do the work, on about *one-tenth* of the usual pump horsepower.

You cut maintenance cost, too. There are no pump parts, valves, or fittings being chewed up in mud agitation service. The only parts that touch mud are the LIGHTNIN Mixer shaft and impeller—easily replaced at any time, for as little as *one-third* your present upkeep cost.



KEEP MUD IN TOP SHAPE with this simple system. One or two LIGHTNIN Mud Mixers (A) have rotating turbines that keep mud flowing, equalize it quickly. Mud weight and viscosity change almost instantly when weight and gel ingredients are added through LIGHTNIN Flash Mixer (B) in open-bottom well.

These are some of the reasons why LIGHTNIN mud control is fast becoming "standard" on offshore drilling barges. Independent drilling men and oil companies are getting better mud—for less money—with LIGHTNINS in many land tanks and earthen pits, too.

Doesn't this make you feel that LIGHTNINS for *your* mud mixing are worth a closer look? Here's how to get the facts, firsthand. Ask your LIGHTNIN sales engineer to arrange a field trip to a barge or land rig in your area so you can see LIGHTNINS at work.

You'll find his name listed in Composite Catalog—or just write, wire, or phone us direct.

SEND FOR this free 6-minute picture story. It shows how you get instant mud control and cut costs, too, with LIGHTNIN Mud Mixers.

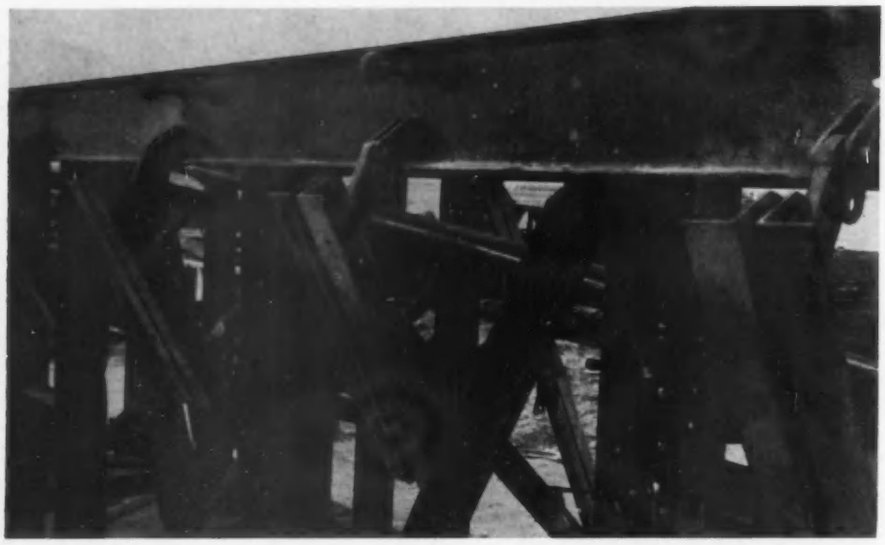
MIXING EQUIPMENT Co., Inc., 197-n Mt. Read Blvd., Rochester 11, N. Y.
In Canada: Greey Mixing Equipment, Ltd., 100 Miranda Ave., Toronto 10, Ont.

"Lightnin" Mixers

How to do it

DRILLING HINTS

$10 is paid for each illustrated acceptable contribution. Mail to The Editor, WORLD OIL, P. O. Box 2608, Houston 1, Texas.



Cantilevers Support Edge of Derrick Floor

To keep road width down on substructures, cantilevers, made from angle iron, are hinged at the bottom and hooked at the top by a pin. After the planks have been removed from the derrick floor, the pins shown at the upper part of the cantilevers are removed and the beams allowed to swing down out of the way and reduce the width of the load by some two feet on each side of the derrick floor. The beams can be swung under the substructure and held in place by re-inserting the pins in the holes at the bottom of the hinge. This puts the ends of the cantilever flush with the side of the substructure and keeps the beams entirely inside the substructure when the rig is on the move.

The cantilevers are made from two angle irons riveted together with space between for the yolk of the hinge and for the clevis welded to the side of the substructure. The hinge is made with two holes, one for the cantilever to swing on and the other for replacing the pin to hold the cantilever under the derrick substructure.

Use Throttle Valve Extension on Pump

With location of the throttle valve on a steam pump a problem on some rigs because of the heat at that end of the pump and the ever-present danger of someone being injured, one operator elevated his floor grating to cover the suction line of the pump, making a handy walkway and working area. By means of an extension to the stem of the throttle valve, he made his throttle valve control convenient to the fluid end of the pump.

An oblong piece of scrap metal was cut and holes placed in it so that it could be attached to two of the studs on the strainer flange. Another hole was drilled at the opposite end of the scrap metal piece. Two bolts were welded adjacent to this hole with their axis perpendicular to the center line of the hole so a clamp screw could be installed. A long rod was welded to the throttle valve stem, extended through this bracket, and a valve wheel attached. The clamp arrangement in the bracket plate holds the valve stem extension in the position of adjustment.

Normally, as the throttle valves get old it is hard to keep them in adjustment due to the vibration of the system. This newer arrangement is not only handier and safer, but it is more reliable because of the clamping device on the valve stem which keeps the pump speed in adjustment.

This is the 20th Year I've delivered their
Season's Greetings
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Tips on Mud Valves for Toolpushers . . .

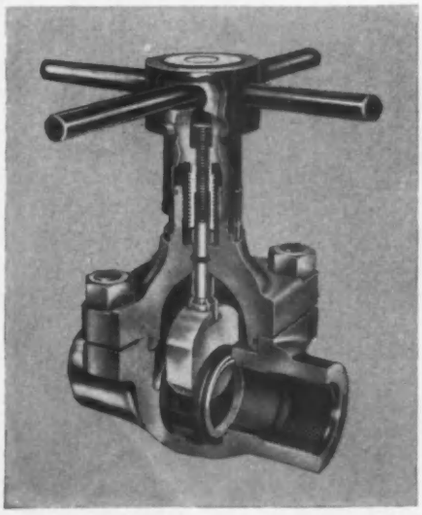
Bill Sauer with a 2" Fig. 2128 MUDWONDER on the mud manifold

Rockwell-Built MUDWONDER Completes 24 Cementing Jobs Without Downtime

By W. E. "Bill" Sauer, Toolpusher
Gabe McCall Drilling Company, Tioga, North Dakota

WITHOUT a doubt the toughest mud valve job on our rig is the standpipe opening we use for bleeding and cementing. There is where we put our first Rockwell-Built MUDWONDER almost a year ago. We have just completed our 24th cementing job through this amazing valve and our books show that the original gate and insert are still in the valve. Previous records for inserts in this service were from 4 to 6 jobs.

MUDWONDER cut-away view shows the double thread construction, separated stainless stem and hard chromed gate with "T" slot connection and the one-piece seat insert with the buna-N molded integrally over the steel wear rings.



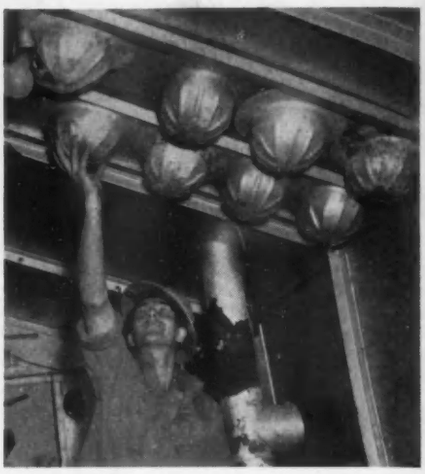
One of the best features about MUDWONDER mūd valves is their easy operation under high pressures. When we bleed off our standpipe we have over 2000 psi pressure. To this day, our 2" Fig. 3128, 3000 psi WP (6000 psi test) MUDWONDER has never stuck or operated hard.

Since we first tried the MUDWONDER we have put them on our jet guns and mud manifold with equal success. Needless to say, we plan to replace the entire mud system with Rockwell-Built MUDWONDER valves as replacements become necessary.

I can recommend MUDWONDER to any toolpusher having mud valve trouble. MUDWONDER valves are available in 2", 3", and 4" sizes with screwed or flanged end for 2000 psi WP (4000 psi test) and 3000 psi WP (6000 psi test).

Your favorite oil field supply store can give you complete information, or write Edward Valves, Inc., East Chicago, Indiana. Shipments are made from East Chicago or the Edward Houston warehouse through the supply store you select. (Adv.)

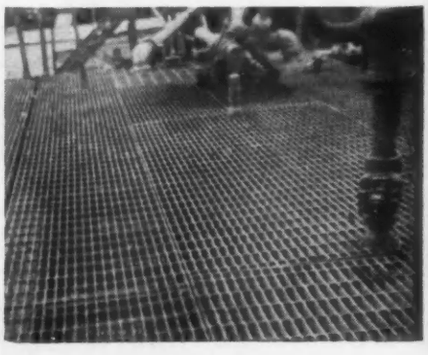
HINTS . . .



Install Doghouse Hat Rack To Ease Storage Problem

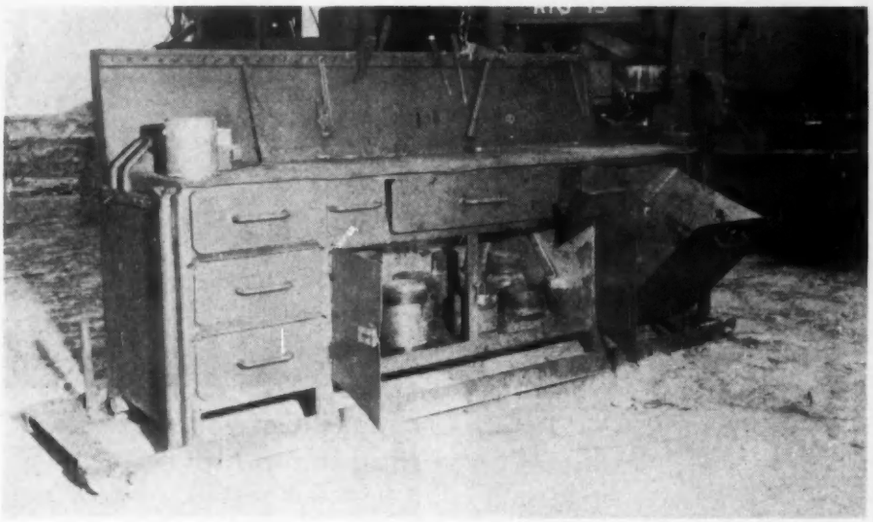
A simple rack, installed in the ceiling of the doghouse, is a convenient place to store tin hats between working periods and to keep safety hats for rig visitors. Make the rack by welding strips of angle iron to the underside of the roof, spaced so the hats can be removed and inserted by turning crosswise. Weld a flat strip to the angle iron roof brace to form the middle bracket member. Use a hat to measure off the distance for the outside two strips of angle iron.

This rack saves space on the doghouse shelves and helps keep everything in its place.



Grating Over Mud Tank Gives Added Working Area

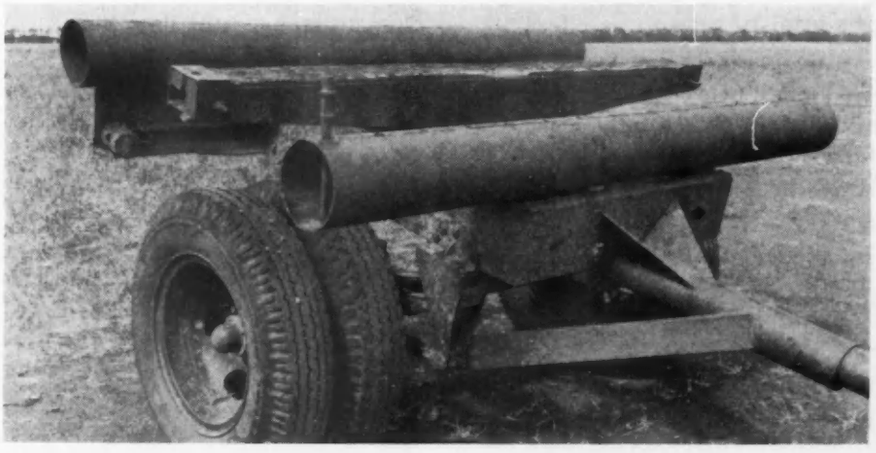
A Gulf Coast oil comany is now using the area over their mud tanks as a working area. This has been accomplished by covering the tanks with a metal grillwork that is made up in sections for easy handling and transportation. This covering also facilitates the addition of caustic and other materials that ordinarily are not added at the hopper.



Skid-Mounted Tool Box Is Loaded Easily

A tool box, which can be moved easily, has drawers for small tools and parts, shelves for the larger ones and a swing-out compartment for wiping rags or other bulk material. All the drawers and the swing-out compartment can be locked by throwing a lever on the side of the doorway opening (arrow). This lever actuates a bar inside the unit which engages in holes in each of the drawers and compartments. The lever can be locked in place and the doors swung shut and locked from the outside with one key. Only one lock is needed for all eight compartments, thus saving time and money.

Top of the tool box provides a work area with a vise mounted on one end. There are hooks for hanging tools temporarily above the bench. On the other end is a telescoping stand for support of pipe in the vise and a hook to facilitate loading box.



Reinforce Trailer for Hauling Drill Pipe

When heavy loads of drill pipe are wearing out the bolster on the pipe trailer, install short pieces of pipe on either side of the bolster to take the load. By using 8-inch pipe in front and 6-inch pipe in back, the three pieces are on the same level and give a much larger bearing surface for the drill pipe.

Cut the back piece of 6-inch pipe to road width and weld it securely to the rear of the trailer. Weld the front piece of 8-inch pipe in place and cut holes in it at six-inch intervals so that a piece of ¾-inch sucker rod material can be used to pin the drill pipe. This arrangement distributes the load on the old truck bolster and makes it easier to load and fasten the drill pipe.

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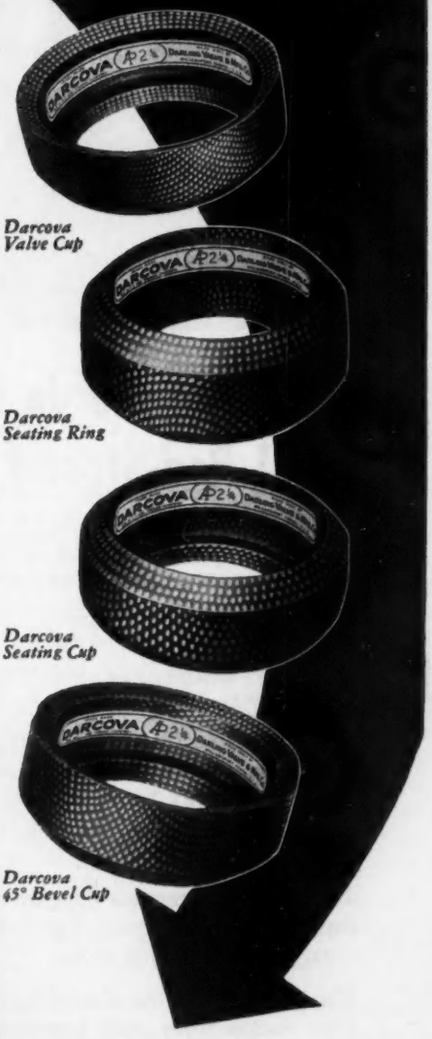

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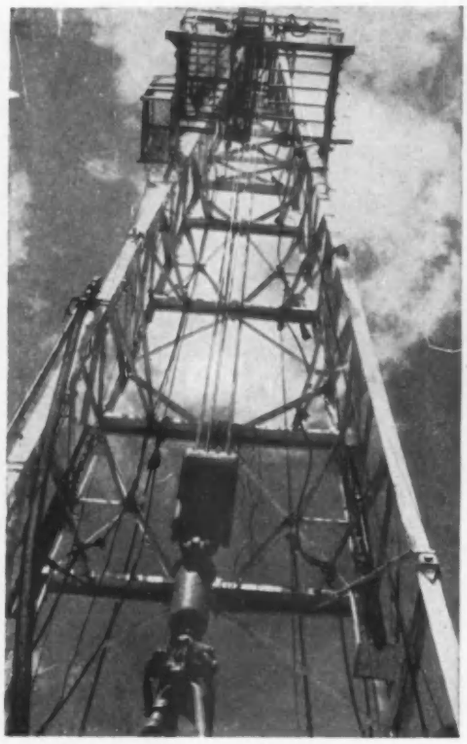

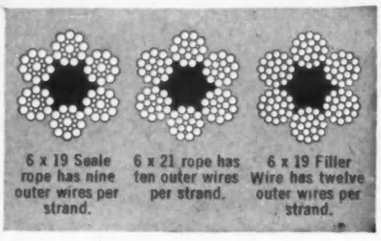
6 x 19 Seale rope has nine outer wires per strand.
6 x 21 rope has ten outer wires per strand.
6 x 19 Filler Wire has twelve outer wires per strand.

What can you do better with 6x21 *Red-Strand* wire rope?

What is 6 x 21 wire rope? It is sometimes called 6 x 16 Filler Wire. It is a construction of intermediate flexibility—between coarse 6 x 19 Seale and flexible 6 x 19 Filler Wire. 6 x 21 is a good choice where the operation includes abrasion and at the same time the rope is subjected to considerable bending. On certain types of duty the choice is vital to save time, effort and money.

When to use it? If, for example, your 6 x 19 Filler Wire rope is wearing out too soon because of abrasion, 6 x 21 with larger outer wires may provide much longer life. If severe bending is damaging your 6 x 19 Seale, a change to more flexible 6 x 21 may be profitable.

It is used on certain dragline jobs, vertical shaft hoists, drag and slackline scrapers, inclines, rotary and cable tool drilling rigs, and other equipment.

Can you use it to advantage? The best answer to that question comes from your Leschen technical man. Leschen representatives will help you get the most out of your wire rope. And with Hercules Red-Strand—as with all other Leschen wire rope, you are assured of *higher-than-rated quality* for *longer-than-expected service.*

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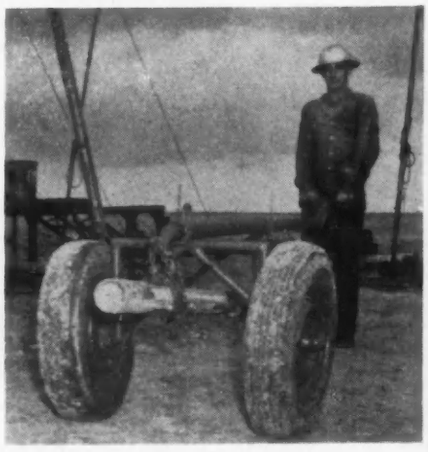
HINTS . . .

Hinged Catwalk Speeds Mud Pump Moves

Instead of making a separate unit of the walkway on the business side of the mud pump, one contractor hinges it to the skids on the mud pump and, when time to move, raises it and chains it to the pump, making a convenient load. The frame is made from 3-inch pipe, with 4-inch nipples cut and welded back together to make the hinges. Cross pieces support grating material that is used for the walk.

In operation, the unions are broken on the piping leading to the pump. The walkway is raised and chained fast and the unit is ready to be moved. When it is spotted on the next location, the walk is lowered, blocked level and the lines connected.

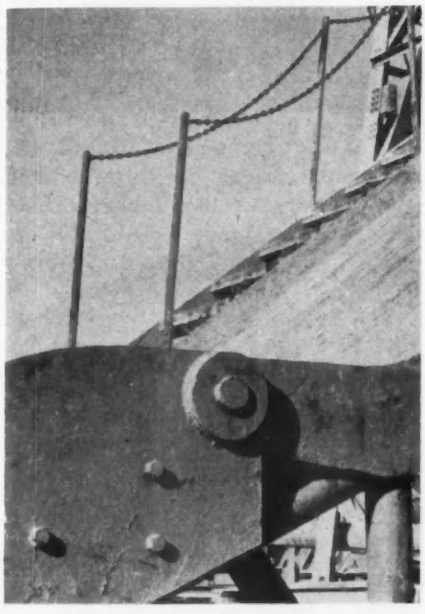


Rubber-Tired Buggy Aids Bit Handling

A buggy made from car wheels and pieces of scrap pipe aids in moving bits and other heavy pieces around a cable tool rig. The axle is cut out of the rear wheels of a car and an inverted V brace, made from 2-inch pipe, is welded into place. The pipe also has braces reaching approxi-

mately six feet back from the center of the wheels. The 3-inch pipe handle with a hook on the front end is tack welded to the front frame and the end where the front braces meet.

In operation, the buggy is wheeled over the bit, the hook lowered by raising the handle in the back, the bit chained on the front and the handle lowered. The bit is chained to it in the back, and, when the handle is raised again, the bit is ready for moving. When the forge or other destination is reached, the process is reversed and the bit is put in place.



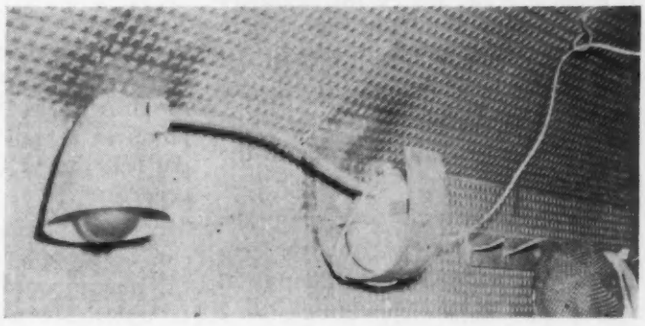
Unitized Slide, Catwalk Saves Rigging-Up Time

For convenience in transporting, handling and erecting the pipe slide and catwalk, one operator has devised a hinge arrangement on the bottom of the slide that fits with a bracket welded and bolted to the catwalk supports so the slide can be folded over and onto the catwalk when tearing down preparatory to moving the rig. This not only keeps the two pieces together, but saves considerable time in rigging up as the two do not have to be handled and aligned separately and then bolted or fastened together in some manner.

This unitization makes a neater appearing arrangement of these two pieces, enables the crew to load only one piece instead of two when moving and the slide is already in position as soon as the catwalk is set. Considerable time and labor is thus saved when rigging-up or tearing down.

Rig Bracket for Geologist's Light

One geologist keeps his fluorescent light right in the doghouse, well out of the way of the crew, yet within easy reach. When the rig is moved, the light is in a safe place and is ready for use on the next location.



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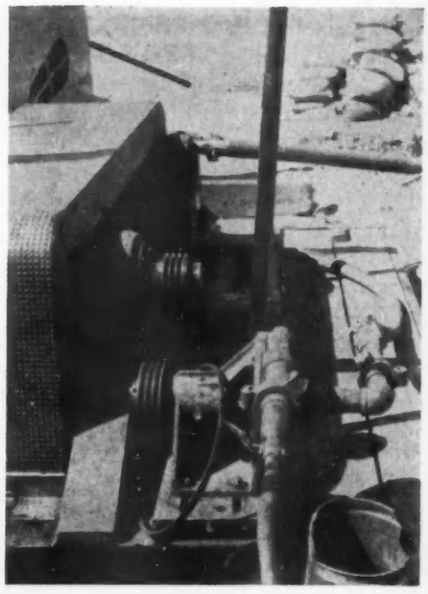
The lamp holder is made from a three-inch strip of ⅛-inch plate that is welded to the side of the doghouse and is curved to fit the round lamp base. The lamp is inserted from the rear of this bracket and rests against a strip that is welded to either side and fits snugly against the top of the lamp base.

A small bracket is welded to the doghouse wall at such a distance from the larger bracket that the lamp head will just clear it. The goose-neck snaps into this small bracket.

Install Power Take-Off For Wash Down Pump

To obtain convenient power to run the wash down pump, install a drive sheave to the compounding unit of the drawworks engines. This puts the pump at a convenient place so that the belt can be kicked on and off as needed.

Set the pump in slots cut in the end of the engine skid base so that the pump can be adjusted for V-belt tightness. The power end is an extension of the drawworks drive shaft on



the engine compound. Install the pump and adjust the belt tension, hook up suction and discharge lines hoses, and the pump is ready for action without using outside power.

Counterweight Balances Barge Tool Box Lid

On drilling barges where tool boxes are not moved on trucks, use a simple counter-weight to make it easier to lift the box lids. After the tool box has been made, fill a short length of 6-inch pipe with sand and weld it shut on both ends. Weld bars along the top of the tool box and weld the weighted pipe to the end of the bars so that it counterbalances slightly more than half the weight of the tool box door.

The counterbalanced lid makes access to tools and parts stored in the box much more convenient. Because of the ease of raising and lowering the lid, the crew is more likely to close the box after getting material.

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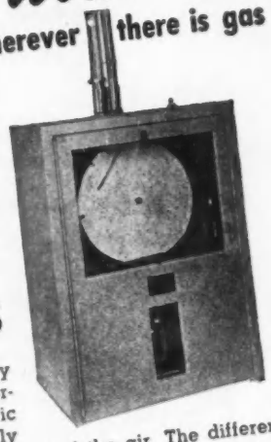

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OIL PRODUCTION IN THE ROCKIES

Source, problems and practices in these major basins:

- Denver-Julesburg Basin
- Williston Basin and Northern Montana
- Powder River Basin
- Big Horn Basin
- Wind River Basin
- Uinta Basin
- Green River and Washakie Basins
- Four Corners Area
- Laramie Basin
- Hanna Basin

By J. A. DONALDSON, Senior Production Engineer,
Continental Oil Company,
Denver

Because of the vast geographical expanse that is commonly referred to as the Rocky Mountain Area, it is impossible to generalize on any of the data, features, problems or practices. Therefore each of the geologic basins have been written up separately with emphasis placed on a few of the fields from each basin.

Denver-Julesburg Basin

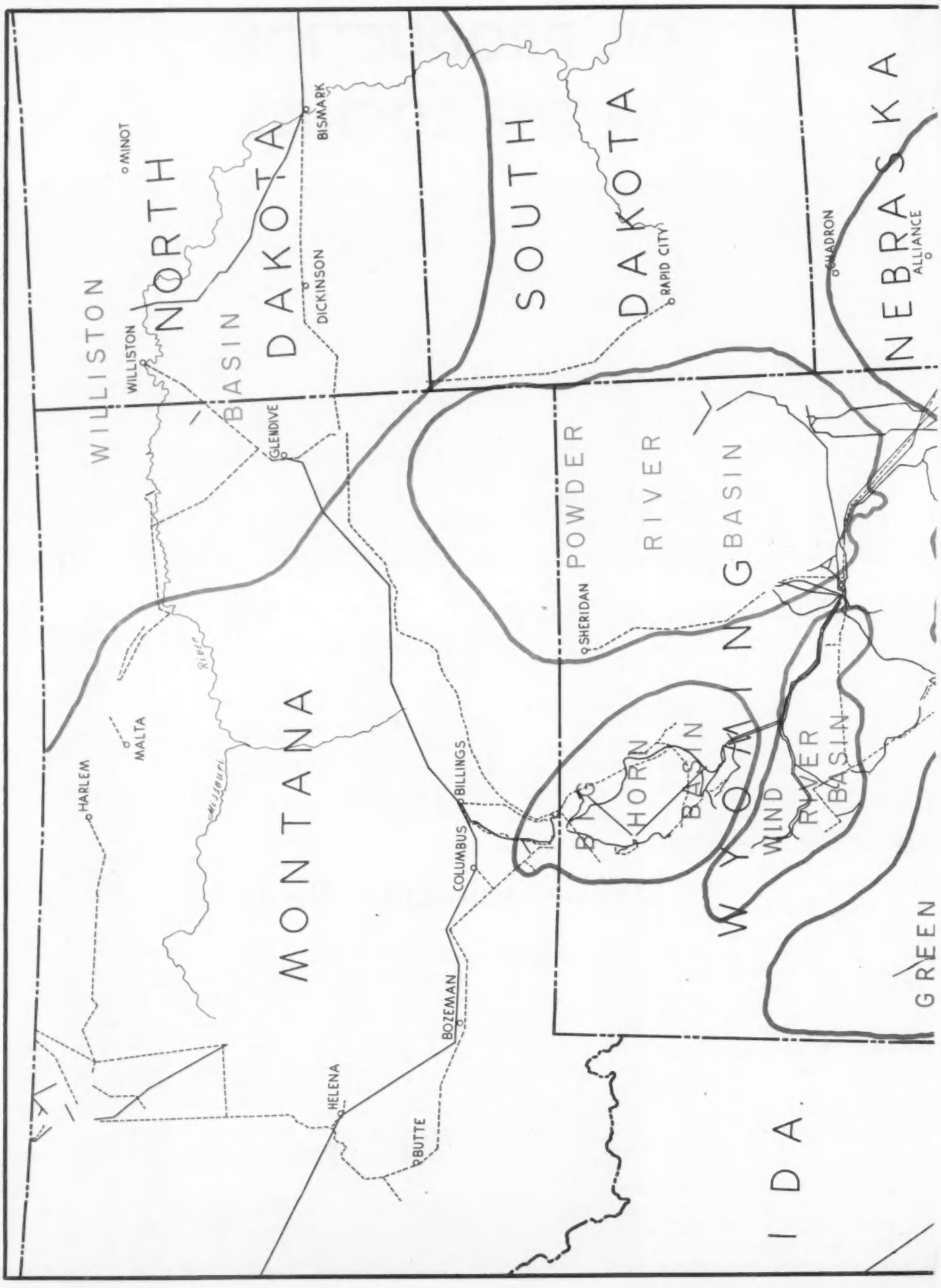
THE DENVER JULESBURG BASIN lies in southeastern Wyoming, western Nebraska, eastern and northeastern Colorado. It is an area 350 miles north to south and 250 miles wide which is outlined by the Chadron Arch on the northeast and east, the Las Animas Arch on the southeast, the Apishapa uplift on the southwest and the Front Range-Laramie Range on the west.

The first production west of Pennsylvania was found in shallow wells at Oil Creek near Canon City, Colorado in 1862. The production was found in a fractured zone of the Pierre Shale. Exploration of the Basin was very slow and sporadic. Boulder field was discovered in 1902 with production of gas and oil from the Dakota sandstone. Fort Collins field was discovered in 1923 and Greasewood field was discovered in 1930. Both of these fields produce from the Dakota sands. Outside of some scattered wells there was very little drilling until 1949 when the Gurliz pool was discovered in western Nebraska. Since this discovery there has been extensive exploration and development drilling. There are 69 drilling rigs running at the present time and as of September 1, 1955, 209 producing fields had been discovered in this basin. The daily oil production is approximately 108,000 barrels.

ACKNOWLEDGMENT

The author wishes to express his thanks to the following men for their cooperation in helping prepare this article: H. C. Pokrandt, district engineer, Continental Oil Company, Powell, Wyo; L. B. Curtis, district engineer, Linch, Wyo.; R. E. Larson, district engineer, Thermopolis, Wyo.; Wallace Tucker, senior production engineer, Thermopolis; J. A. Glover, production engineer, Thermopolis; W. S. Akers, district engineer, Glenrock, Wyo.; W. F. Schwenn, production engineer, Denver; and D. R. Worth, district engineer, Denver.

The main producing formations are the Lyons, of Permian Age, and the Dakota group of Cretaceous age known as the "D," "G" and "J" sands. The Lyons sandstone is productive in three fields in Weld County, Colorado at depths of approximately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SOUTH DAKOTA
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MONTANA
WYOMING
IDAHO
POWDER RIVER BASIN
BIG HORN BASIN
WIND RIVER BASIN
GREEN
MINOT
BISMARK
WILLISTON
DICKINSON
GLENDIVE
RAPID CITY
QUADRON
ALLIANCE
SHERIDAN
MALTA
HARLEM
BILLINGS
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BOZEMAN
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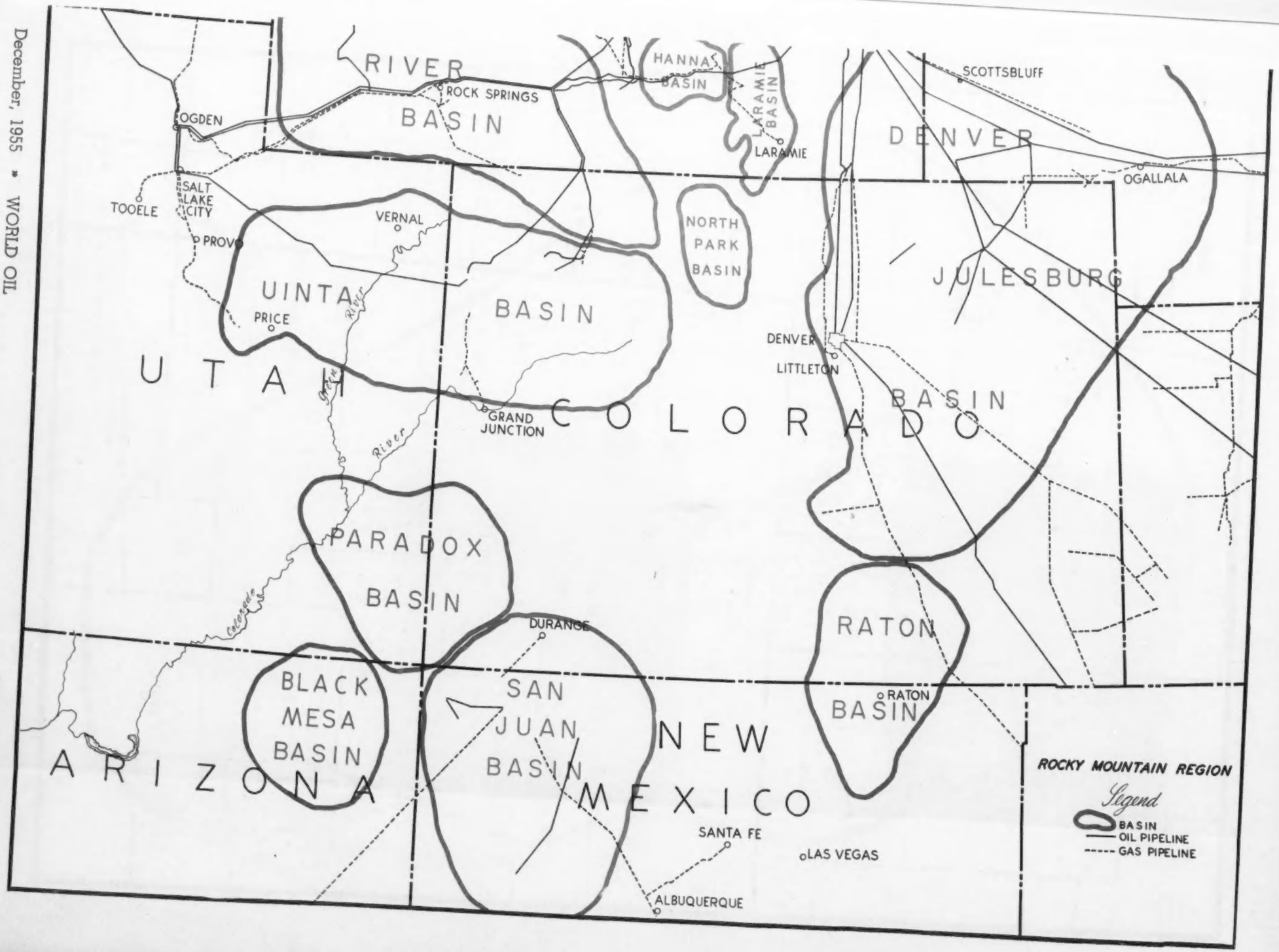
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SALT LAKE CITY
PROVO
VERNAL
NORTH PARK BASIN
JULESBURG
UINTA BASIN
PRICE
Green River
DENVER
LITTLETON
UTAH
COLORADO
BASIN
GRAND JUNCTION
Colorado River
PARADOX BASIN
DURANGO
RATON
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RATON
BLACK MESA BASIN
SAN JUAN BASIN
NEW MEXICO
ARIZONA
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LAS VEGAS
ALBUQUERQUE
ROCKY MOUNTAIN REGION
Legend
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OIL PIPELINE
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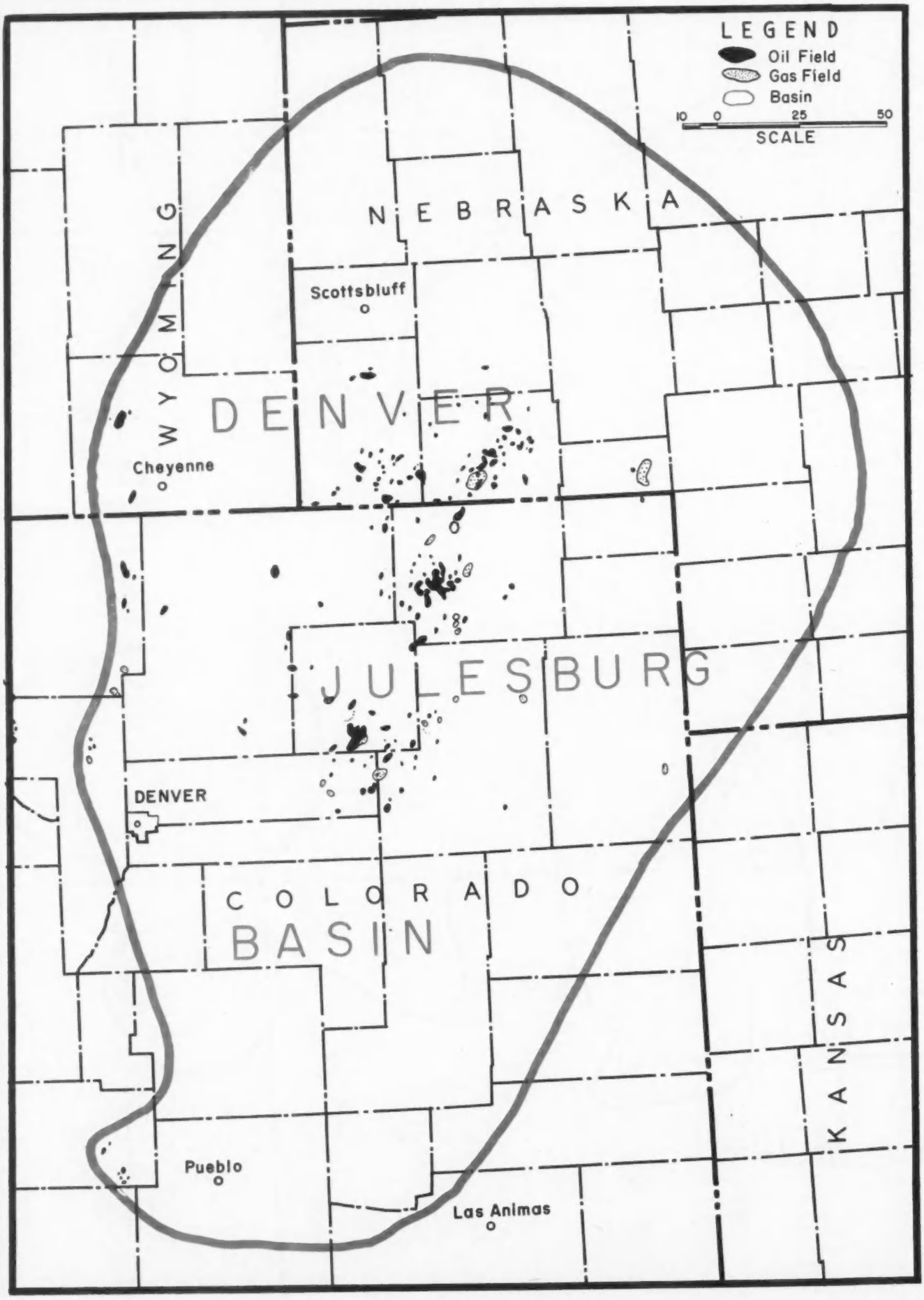
LEGEND
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WYOMING
Scottsbluff
DENVER
Cheyenne
JULESBURG
DENVER
COLORADO
BASIN
KANSAS
Pueblo
Las Animas

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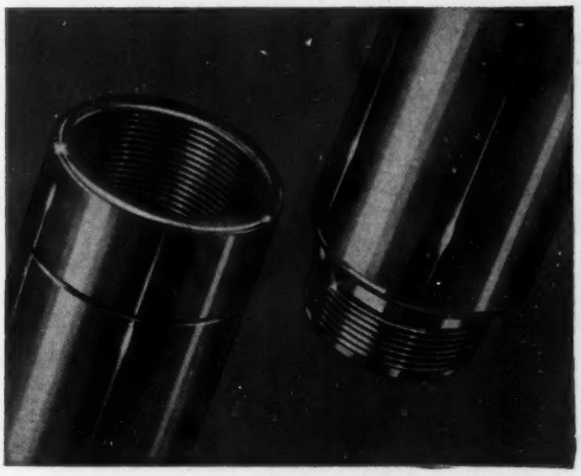

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9000 feet. The gravity of this oil is 36° API, paraffin base with low sulfur content, and a pour point below 70° F. The Dakota group production is usually found in sand lenses or stratigraphic traps with very little closure or structure. The "D" and "J" vary considerably in thickness from pool to pool and each sand is usually composed of separate zones. Production may be found in only one zone and in some instances upper sands may be water bearing and oil found in lower sand or zone.

Drilling and completion of wells in the basin is unusually fast and simple. The depths range from 5000 to 5500 feet and some wells have had an elapsed time of seven days from spud-in to completion. Casing is set through and perforated. The rigs are often skidded between locations and in this manner a new well is spudded and surface pipe set and cemented in less than 12 hours time from release at the old location.

The gravity of the Cretaceous oil varies from 35° to 43° API and contains a fair amount of paraffin. It is sweet oil and has a ready market. Treating problems are minor and some heat with chemical is generally needed to separate water and basic sediments.

Paraffin accumulation or build-up in the flow lines varies and in many instances paraffin in the tubing, has been one of the major production problems in the Denver Basin. This is probably due to the high paraffin base oil that is found in this area. A new process of effectively internally coating pipe lines and flow lines in place with a thin plastic coating has merit in combating this situation. In some instances, previously coated tubing has been placed in the top 1000 feet of an oil well tubing string and this has reportedly reduced paraffin accumulated in tubing strings. Additional time and more coating jobs will have to be performed to completely evaluate this process. However, present reports indicate it has definite merit in combating paraffin build-up.

Williston Basin and Northern Montana

The Sweetgrass Arch is a large surface feature culminating in north-central Montana and plunging northward across the International Boundary into southern Alberta. The broad gentle arch begins at the Red Deer River in the northeast corner and rises to a culmination in the Kevin-Sunburst Dome just south of the boundary. South of the Kevin-Sunburst Dome is a northwest plunging nose called the South Arch. These are separated by the Marias River saddle or syncline. The Sweetgrass Arch is bounded on the west by the foothills belt of the Rockies. The most important oil accumulations occur on the north flank of the Kevin-Sunburst Dome.

Geology—A brief outline of the stratigraphy, structure, and historical geology is as follows: In North America a very gentle regional unconformity is recognized at the base of the Exshaw and its equivalents. This is the geological boundary between the Devonian and the Mississippian. The Mississippian section consists of massive grey limestones in the upper part, and shaly, sandy, thin-bedded limestones in the lower part. In post-Mississippian time, a profound orogency caused folding and faulting in areas of thick Paleozoic sediments, and broad up-warping in areas of their deposition.

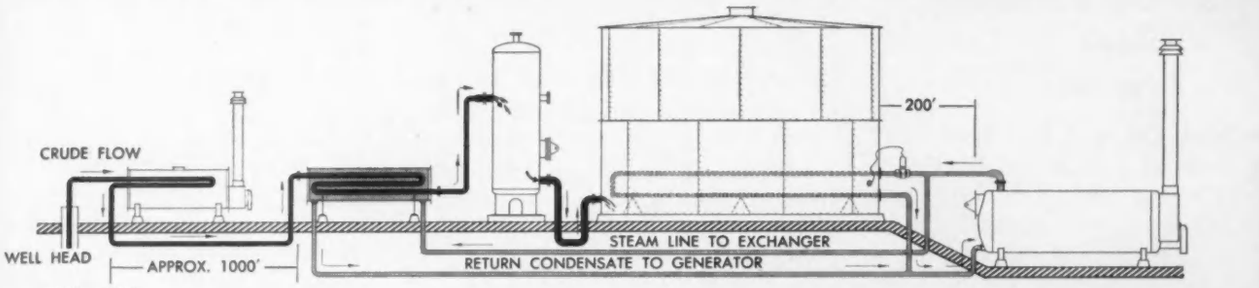
This was followed by long periods of erosion and weathering which lasted well into Jurassic time in the Sweetgrass area. The resulting limestone erosion surface is leached, fractured, dolomatized, with marked local porosity. Buried escarpments are a common feature. Karst topography, sink-holes, and underground streams occur, and the joints are commonly weathered out to a considerable depth. Elevated areas are deeply dissected, and have many topographic irregularities, while low areas are gently rolling. An irregular erosional drainage pattern is superimposed on the ancient surface resulting in a series of valleys and ridges modified to some extent by more resistant limestone escarpments. Although the South Arch is shown on many maps as terminating abruptly on a fault just northwest of the Pondera field, the evidence is inconclusive and it may be a buried escarpment.

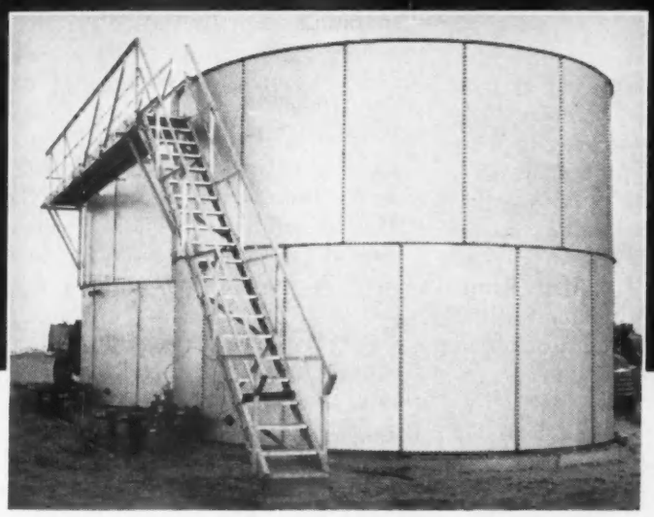
Topographic relief on the post-Mississippian erosion surface was great enough so that Lower Jurassic is largely absent in Montana and southern Alberta, and islands persisted up into Swift time. The marine Ellis group is Middle and Upper Jurassic and has been divided into three formations. These consist largely of light brown to grey shaly to limy sandstones and shale in upper part, and dove-colored to black shaly limestone, limy shale, and a basal fine-grained sandstone in the lower part. The Jurassic is important in that the basal sandstone, where present, commonly forms part of the Ellis-Madison carrier zone because the Jurassic shales provide an adequate cap rock. The marine Jurassic is graduational with the overlying Morrison continental series. A short period of post-Jurassic erosion removed the Morrison over most of the Sweetgrass Arch, except in the western part and south of Great Falls, and stripped the Swift off the northern part of the Arch and in the Cut Bank area.

The Lower Cretaceous Kootenai was deposited over the eroded Jurassic surface. In the Cut Bank area the Cut Bank sand is the basal member and wedges out on the flank of the Kevin-Sunburst Dome. The younger Sunburst sand finally covered the Kevin-Sunburst Dome and is the basal sand in the Kevin-Sunburst area. Several other sand members occur in the Lower Cretaceous (continental) but these are very irregular and lenticular, and very local in extent. The overlying Colorado shales (marine) have two important blanket sands of considerable extent, the Viking equivalent of Central Alberta or Bow Island (Blackleaf) member, and the Cardium equivalent or Medicine Hat sand. Important gas accumulations occur in these zones, especially in southeastern Alberta. The steeper west flank of the Sweetgrass Arch is largely due to superimposed down warping as a result of the thick Mesozoic sedimentary section to the west and on account of the excessive loading resulting from the piling up of the strata in the mountains and foothills.

PRODUCTION PROBLEM SOLVED IN UINTAH COUNTY NEAR VERNAL, UTAH

Problem — To handle 240 barrels per day of 37-degree gravity oil with a pour point of 90-degrees.





Solution — National Tank Company equipment is set as per the above flow diagram. An indirect heater is set at each well head for a flow line heater in order to keep production at a high enough temperature to prevent congealing in the lines. Before separation, the production is subjected to an additional heat through a Steam Heat Exchanger so that gas can properly be separated from the oil in the oil and gas separator. Each tank is thermostatically controlled at a temperature of 110° preparatory to being shipped by truck as there is no pipeline connection available at present time. A 4' x 15' two million BTU 15# W. P. National Steam Generator is installed along with coils in each tank to keep the production to 110-degrees in the stock tanks. This is a closed system with the generator set at a lower level than the tank grades and the condensate line buried from the tanks back to the unit. Atmospheric temperatures in this area range sometimes as low as 40° below zero in the winter months.

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Table of Formations

Cretaceous	Colorado	Blackleaf
	Kootenai	(Sunburst
		(Cut Bank
Unconformity		
Jurassic	Morrison	
	Ellis	(Swift
		(Rierdon
		(Sawtooth
Unconformity		
Mississippian	Madison	(Mission Canyon
		(Lodgepole
	Englewood	
Gentle Regional Unconformity		
Devonian-Upper		
	Three Forks	(Grassy Lake
		(Potlatch
	Jefferson	

Cut Bank Oil and Gas Field. The Cut Bank oil and gas field is located along the west flank of the Sweetgrass arch. It is approximately 25 miles west of the Kevin-Sunburst Dome which is the northern most of the two on echelon folds comprising the Sweetgrass Arch.

The north Cut Bank Madison pool is the only production in the Cut Bank field which is structurally controlled. Accumulations, at depths of 3100 to 3200 feet, are effected along the north plunging anticlinal nose. East-west reversal on this nose is approximately 150 feet and there is a high-angle fault, down thrown to the east, along the east side of the pool. The trend of the trace of this fault parallels the trend of the anticlinal nose.

Structure—The balance of the production in the field, from the Cut Bank and Lander sandstones, is stratigraphically controlled and is effected by an eastward up-dip pinchout of the Cut Bank sand at depths of 2900 to 3200 feet. South of the north Cut Bank pool, regional dip is relatively uniform to the west-southwest at the rate of 75 to 100 feet per mile.

Stratigraph—Production in the Cut Bank field is from the sandstones within the Kootenai formation and from the upper portion of the Madison group.

The Kootenai formation varies in thickness from 500 feet on the east side of the field to 650 feet on the west side. It consists of red, green, brown and dark grey shales and mudstones with interbedded lenticular siltstones and sandstones.

The Cut Bank sandstone, at the base of the Kootenai, averages 50 feet in thickness and is a grey, salt and pepper, cross bedded sandstone. It is shaly and fine grained in the upper part and becomes coarse-grained and conglomeratic toward the base. The sand contains varying amounts of black chert and is sometimes pyritic, particularly in the lower portion. The changing lithology of the sand results in a wide range of porosities and permeabilities.

Production from the Madison limestone in the North Cut Bank comes from zones of porosity both at the top of the unit and to 75 feet below the top. The upper Madison in this area consists of creamy buff to grey, crystalline limey dolomites which may be the equivalent of the Charles formation in eastern and central Montana.

Drilling and Completion Practices—Wells drilled with cable tools normally set 10⅝-inch surface casing through the two Medicine and Eagle formations about 25 feet into the Colorado. In the event of water in the lower Colorado or upper Kootenai, an 8⅝-inch cave string is run, followed by a 7-inch or 5½-inch production string. The cave string is usually recovered and, in the event of a dry hole, most of the surface string. Wells drilled with rotary tools normally set less surface casing with the same amount of production casing. Until recently the usual practice in areas of sand production was to set a production string 5 to 10 feet below the top of the Cut Bank sandstone. At the present time most of the operators prefer to set the production string through the Cut Bank sandstone into the Ellis shale from 25 to 40 feet. The casing is then selectively perforated on the basis of core analysis and/or electric or radioactive logging. Recently, sand fracing has become increasingly successful, particularly in new wells where the formation is tight. Sand-oil squeezing has increased production on new well completions 30 to 50 bopd. The average mix consists of 1 to 1½ pounds sand, and sufficient adomite to control fluid loss, mixed in one gallon of crude oil. Sand-oil squeeze jobs have not been too successful in depleted areas.

In the North Cut Bank pool, most of the wells drilled are completed by setting the pipe through the production zone, then perforate and acidize with 500 to 1500 gallons of acid.

- **Logging**—Well logging consists of the conventional electric log and microlog. The radioactive log is run after the casing is cemented primarily for correlation purposes.
- **Treating**—In the North Cut Bank field (Madison Limestone) the use of treaters and chemicals are necessary. Treaters are operated at 130°-140° and emulsion breaking chemical is used.
- **Paraffin**—When the Cut Bank reservoir was initially produced, paraffin deposition was experienced in the tubing and flow lines. As the reservoir was depleted, it is thought this deposition is now at, and in the vicinity of the well bore. Electric formation heaters (5 to 15 kw in size) have been installed in approximately 50 wells. These heaters are placed below the pump on the tubing string opposite the formation. The installation of the heaters has increased production approximately 8 bopd/well. It has been noted that the heaters can be operated for 3 to 6 months following their installation and then be turned off. In most cases the wells will maintain their increased production. No paraffin deposits are experienced in the North Cut Bank field.
- **Corrosion**—Only a few isolated cases of exterior galvanic corrosion have been experienced. In the North Cut Bank field, H_2S corrosion in gas section of tanks has been a problem. Galvanized tank tops have controlled this.

Secondary Recovery—The Texas Company has a pilot flood in operation in the Cut Bank Sand. The flood is a five-spot pattern. When the five-spot producing well was drilled, it was found that the lower section has permeabilities up to 500 md., where the remaining section of the reservoir has permeabilities of 5 to 10 md.

What appears to be a successful pilot flood is being conducted by Carter in the Lander sand on the northwest edge of the Cut Bank field. This sand is quite uniform and is considered a good prospect for large scale flooding.

Darling Field. Production in the Darling field is from the Sunburst (Moulton), Cut Bank, and Madison (Charles). Operations are the same as in the Cut Bank and North Cut Bank fields.

Williston Basin-Cedar Creek Anticline-Pine Unit Field—

The Pine Unit field is located on the southwestern flank of the Williston Basin and is located on the northwesterly trending Cedar Creek anticline in Dawson, Prairie, Wibaux,

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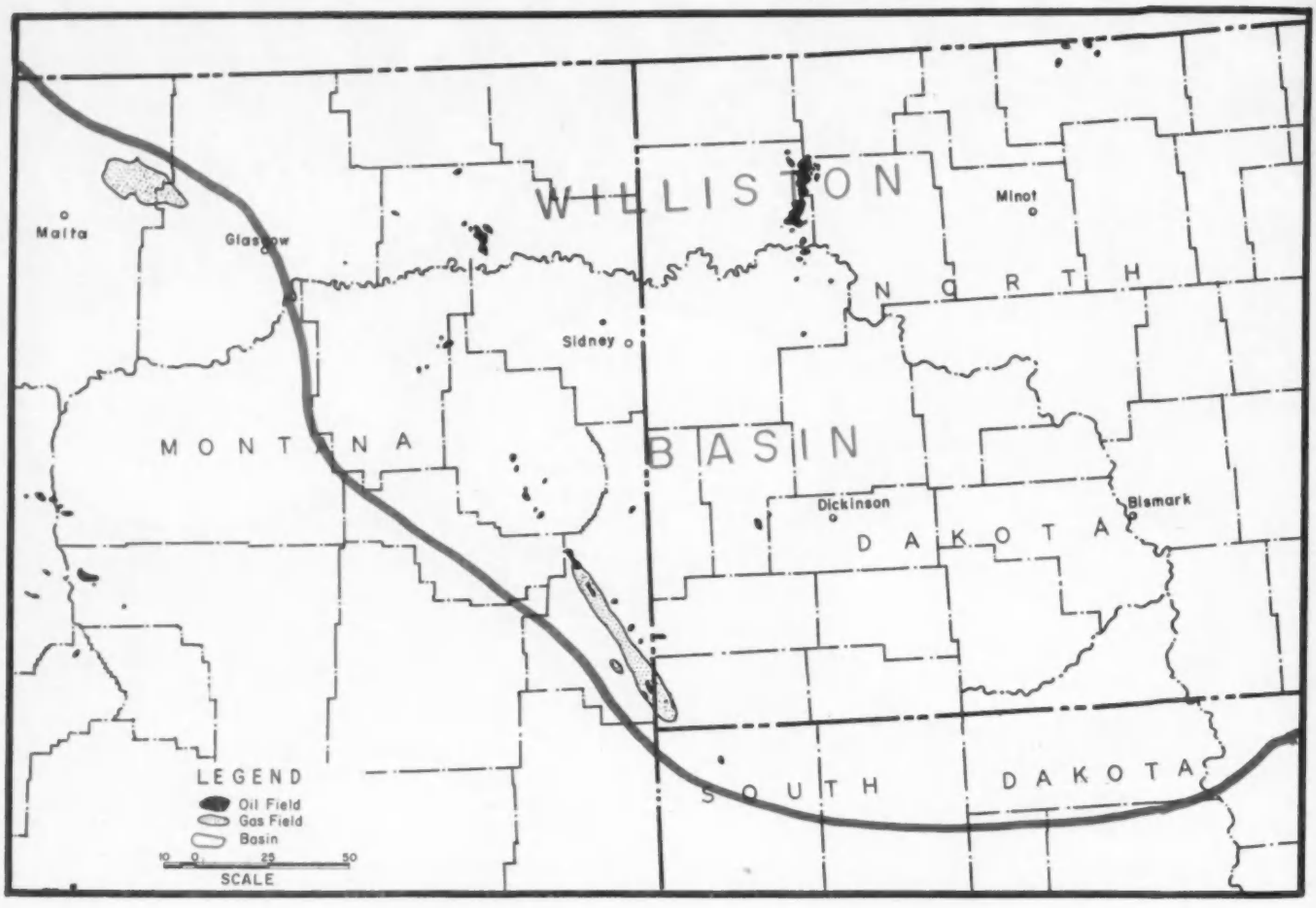

and Fallon counties, Montana. Pine Unit 1, the discovery well, was drilled to test a subsurface seismic closure located near the crest of the known surface anticline. The well was completed in January 1952, for an initial daily pumping production of 467 barrels of 33° gravity crude oil and 148 barrels of water from the Upper Ordovician Stony Mountain formation. Subsequent outstep drilling was notable in that improved reservoir conditions were found in the Ordovician, and Silurian production was established in zones found water bearing in the discovery well.

The Devonian strata, shales and shaly dolomites, serve as effective barriers to vertical migration over Silurian productive zones. Silurian rocks thicken and rise structurally southeastward with associated development of porous and productive intervals. Upper Ordovician strata contain the major productive zones with included shale horizons acting as effective cap rocks.

Development to date indicates oil accumulation in the Pine field to be controlled by structure, but with stratographic variation important in reservoir properties. The structure is basically an asymetric anticline, modified by minor culminations and saddles. Structure contours indicate a closure of approximately 200 feet.

No gas caps are present in the field. Porosities of the pay interval vary from 6 to 16 percent with a mean of 11 percent. The average permeability is approximately 5 md. Connate water in the pay intervals is estimated to average 30 percent.

The crude oil produced is black, 35° API gravity, with a sulfur content of 0.44 percent and a GOR of 150. Reservoir pressure is on the order of 4150 psi. The greater portion of the recovery will be by liquid expansion, and no active water drive has been ascertained as yet.

The field is operated as a Federal unit with Shell Oil Company as unit operator. Working interests in the unitized area are held by Shell, The Texas Company, and Continental Oil Company.

Completion practices are as follows.

- **Surface casing**—Set approximately 1000 feet through surface shales.
- **Production string**—The production string is set through all pay zones if the oil-water contact is not known. Where the oil-water contact is known and the well structural position is suited, the production string is set part way through the Ordovician to the top of the Red River formation. It should be noted at this point that this has been an approved Siluro-Ordovician reservoir with the right to co-mingle. Every other well is completed in the Ordovician with alternate locations in the Silurian.
- **Perforating and Acidizing**—Where the Silurian and Stony Mountain formations are produced, the casing is perforated and a natural swab test is made for a period of 12 to 24 hours. The acid program usually consists of stage treatments of regular acid, inhibited acid, and acid petrofrac's with sand. The petrofrac's can contain up to 1½ pounds of sand per gallon of kerosine.
- **Casing Collapse**—There has been one casing failure in the Pine field. However, this problem has been more acute in other fields in the Williston Basin. Along the Cedar Creek Anticline, the failures have

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been in Spearfish and Opeche salt sections. It is the practice to two-stage cement all production strings. The two-stage collar is placed below the lowest salt section. It was thought that protection was obtained through the salt sections from the cement. An analysis of several section gages and temperature surveys indicated large washouts in the salt sections and cement channeling through these washouts. The first control step was to use a supersaturated salt mud (300,000 ppm) to control the hole size. This has been successful. The second step was to use a salt cement to prevent the salt from leaching the water from the cement. The above is now part of the program. It appears the desired fill up of cement behind the casing is being obtained. In addition, heavier casing is being set opposite these sections.

- **Mud**—Native fresh water muds are used to 5000 feet or above the Spearfish. Then a supersaturated salt oil emulsion mud is carried until the production string is cemented. The oil emulsion was selected to counteract the additional weight of the salt.
- **Logging**—The laterolog and microlaterolog are used because of the high resistance of the mud. A radioactive log is run with radioactive elements included in the cement to check the fill up.

Logs, DST's cores, and cuttings are evaluated to determine completion procedures.

It may be noted at this point that the bottomhole temperatures in the Pine field are about 200°. Necessary precautions are observed in cementing and acidizing operations to allow for this BHT.

Production operations include the following:

- **Treating**—Treaters and chemicals are used to break the emulsion in the Pine field. The treaters are operated at 120° to 140°. Wash tanks are being installed in place of treaters as a gravity conservation measure.
- **Corrosion**—No corrosion is apparent at this time. However, exterior galvanic corrosion in buried pipe is suspected. Operators are now in the process of running soil resistivity profiles on all buried lines. As an additional precaution, all buried pipe is being wrapped and treated.
- **Remedial Work**—Remedial work to date has consisted of attemting to shut off bottom water, reperforating, and acidizing.
- **Secondary Recovery**—The field is in the early stage of development and the recovery mechanism has not been fully evaluated, but porosity and permeability variations may limit water-flooding.

Northwest Sumatra

Heath Sand

- **Treating**—Crude is easily treated. Treater temperatures range from 110°-120° on both Heath and Amsden wells. Chemical is used at two wells.
- **Corrosion**—Nothing to date indicates corrosion as being a problem. A survey of ground resistivities is underway to determine if external galvanic corrosion is taking place.
- **Paraffin**—Paraffin deposition is experienced in the top 1500 feet of tubing and in the flow lines. Paddle rods are installed in the wells and controls the tubing deposits. All the subject wells have 3-inch flow lines. Go-devils are run every three days keeping the flow lines free of paraffin.
- **Crude Oil**—Averages 34° API gr. @ 60°, under saturated, pour point —5° F. to — 15° F.
- **Secondary Recovery**—A testing program is planned to determine reservoir volumes and whether or not communication exists between the sands. The small amount of gas available would make a gas injection program uneconomical.

Amsden

- **Treating**—As above—No chemical used.
- **Corrosion**—As above.
- **Paraffin**—None.
- **Crude Oil**—29° API gr. @ 60°. This well has a fast decline.

Cat Creek

Mosby Dome—Antelope Dome

The above fields will be considered as one in regard to the following:

- **Corrosion**—Galvanic corrosion has been noted in tubing and pumps of several wells that produce water.
- **Treating**—None. The gravity separation of oil and water is sufficient.
- **Paraffin**—None.
- **Crude Oil**—49° to 52° API gr. @ 60°.
- **Secondary Recovery**—Scheduled installation of pilot water-floods at Cat Creek and Mosby Dome during 1956.

Powder River Basin

First known oil production in the Powder River Basin was in 1887 from several oil springs and one shallow well in the Moorcroft field, Crook County, Wyoming. This oil, produced from the Newcastle sand or Muddy equivalent, was used to supply the Black Hills Gold Mining operations. Oil produced from this field was 22 API gravity and the quantity produced is unknown.

Some 60 well were eventually drilled to about 600 feet on the flanks of this typical anticlinal trap. The second venture in oil field development in the basin was in 1889 when a 700-foot well was drilled near and oil seep in the river bed of Salt Creek just north of Salt Creek field proper. Several wells were drilled in this area which was later called the Shannon field after its operator. Cumulative production was 53,441 barrels of 34° API gravity oil. In 1908 the second Frontier reservoir (also called 2nd Wall Creek) in Salt Creek Field proper was discovered.

This well started development of the largest oil field in Wyoming. Development continued through 1917 and even then development was not complete. Since the first discovery in the Powder River Basin over 50 oil and gas pools have been found, and with the exception of one field, all have been around the margin of the basin. The one exception to this is the Adon field in Campbell County, Wyoming. One well was completed in the Minnelusa formation in this field, so the economic significance is not as note-worthy as the geologic bearing which serves to preview the oil producing potential of the central portion of the basin. It is of interest to note that the bulk of the oil and gas reserves discovered thus far are in the southern one-third of the basin.

Also, the really large oil reserves have been found on the south and southwest perimeter of the basin in anticlinal traps. (Actually, two fields, Salt Creek and Lance Creek, have

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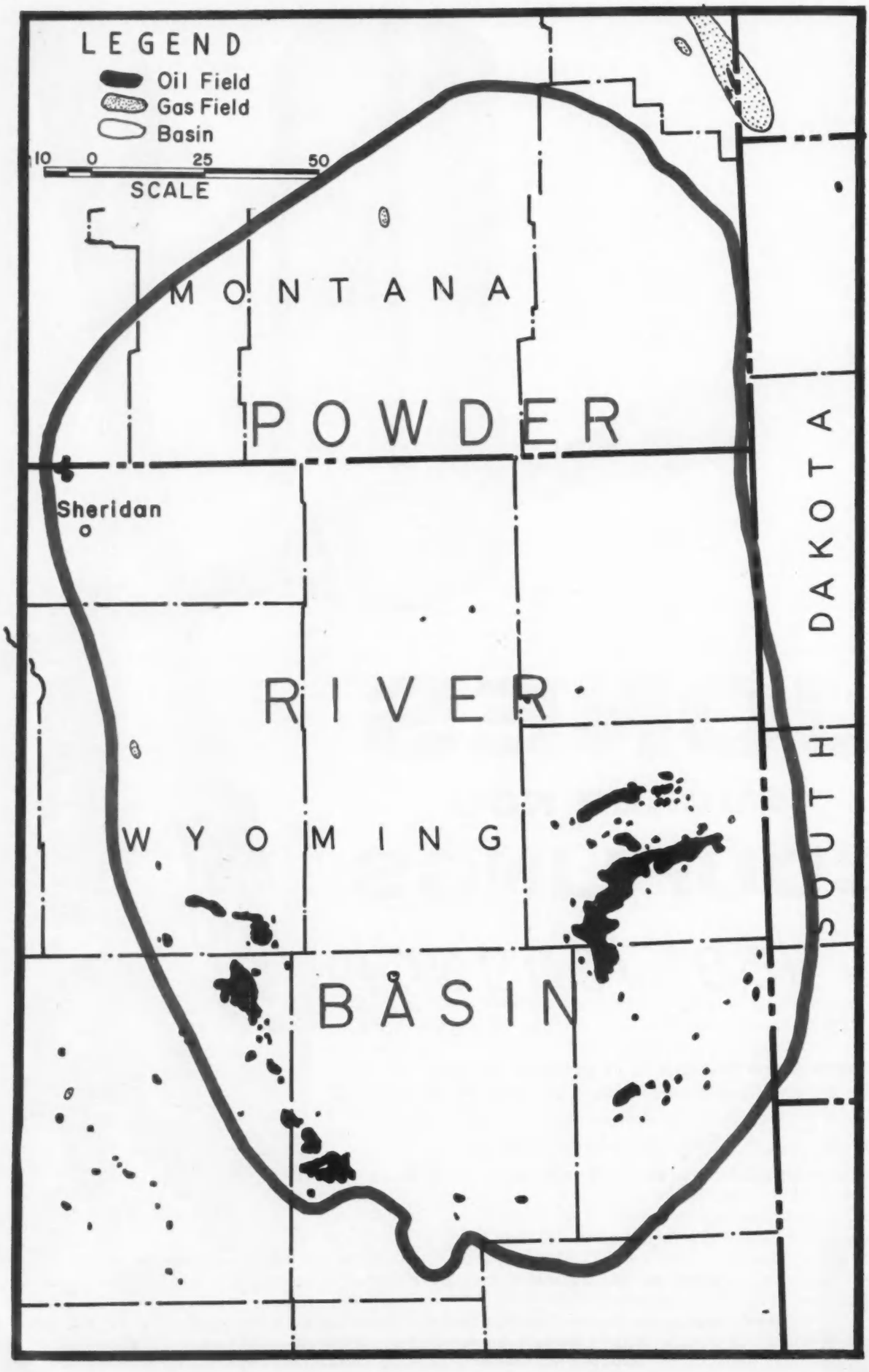
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RIVER
BASIN
WYOMING
SOUTH DAKOTA
Sheridan

produced over 80 percent of the oil from the Powder River Basin.) This is not particularly unusual as it is in this area that a number of anticlinal structures are reflected on the surface. The noticeable absence of surface indicated anticlinal folds along other segments of the basin perimeter has been a "main" topic of discussion for several years.

It is thought by some geologists that the folds are actually present, but are masked by thick Tertiary deposits. In general, oil accumulations have been found in monoclinal terraces and/or stratigraphic traps on the eastern perimeter of the basin. This is a particularly noticeable feature when compared to the western margin, but may not be unusual in view of the tectonics of the Black Hills Uplift.

Recently, major oil reserves were discovered in the Sussex area northeast of Salt Creek Field and in the Glenrock area southeast of Big Muddy Field. The shallow Cretaceous reservoirs in the Sussex area are fault traps along the crest and flanks of a series of structures. The deeper accumulations are combination structure and fault type reservoirs. The Cretaceous reservoirs found at Glenrock are apparently combination structural and stratigraphic traps. These reservoirs have greatly increased the known oil reserve of the Powder River Basin, but again are in the southwestern part where numerous anticlinal folds are evident on the surface. One other major oil reserve found recently is the Clareton-Cheyenne River area field in the Newcastle Sand. This appears to be a stratigraphic accumulation in the channel of old river bed or possibly a lagoonal type offshore deposit.

TABLE 1—Salt Creek Field, Natrona County, Wyoming.
Total No. of Wells Drilled to Date: 2458
Total No. of Wells Now Producing: 1033

FORMATION	Depth	No. of Wells	Discovered	Prov. Area	Lithology	Net Thick.
1. Upper shales in Steele form.	Less than 900′	Drl'd 167 Now prod—12	1906	.....	.....	40′
2. 1st Frontier (Wall Cr.)	934′	Drl'd ? Now prod—142	1908	4,125 Ac.	Salt and Pep. Grey Med. Gr. SS	100′ Gross
3. 2nd Frontier (Wall Cr.)	1380′	Drl'd ? Now prod—781	1908	21,450 Ac.	Same	70′ Gross
4. Crd Frontier (Wall Cr.)	1420′	Drl'd ? Now prod—7	1908	Spotty	Same	15′ Gross
5. Muddy Sand	1575′	Drl'd 18 Now prod—14	1925	360 Ac.	Sand Med. Gr. Grey SS w/num.	11′
6. Lakota Sand	2280′	Drl'd 64 Now prod—23	1921	2,000 Ac.	sh. streaks Med. Gr. Sd.	40′
7. Morrison	2592′	Drl'd 1 Now prod—1	1929	50 Ac.	Sand Wh to Grey Coarse Gr. Fn.	3′
8. 1st Sundance	2610′	1 Plug B Now prod—1	1952	?	Red to Pink SS	.....
9. 2nd Sundance	2785′	Drl'd Now prod—7	1925	340 Ac.	Fn Gr: Red to Pink SS	40′ Gross
10. 3rd Sundance	2945′	Drl'd Now prod—28	1925	900 Ac.	Fine Gr. Wh. to Grey SS	37′ Gross
11. Tensleep	3775′	Drl'd 18 Now prod—18	1930	1,005 Ac.	Fn to Med Gr. Buff S.S.	83′

OIL PROPERTIES:	Base	Gravity	Percent Sulfur	Color
1. Steel Pay	Paraffin	36 API	0.1	Green
2. 1st Front	Paraffin	36 API	0.1	Green
3. 2nd Front	Paraffin	36 API	0.1	Green
4. 3rd Front	Paraffin	36 API	0.1	Green
5. Myddy	Paraffin	36 API	0.1	Green
6. Lakota	Paraffin	37 API	0.1	Green
7. Morrison	Paraffin	30 API	0.1	Green
8. Sundance	Paraffin	36 API	0.3	Black
9. Tensleep	Asphalt	27 API	22.	Black

TABLE 2—South Cole Creek and Cole Creek Fields, Converse and Natrona Counties, Wyoming.

FORMATION	Disc. Year	Depth	Drive Mechanism
Cole Creek Field:			
1. Shannon	1940	4500′	Solution Gas & limited water drive.
2. Lakota	1938	7900′	Water drive.
3. Dakota	1938	7950′	Solution Gas.
South Cole Creek Field:			
4. Lakota	1948	8309′	Water drive.
5. Dakota	1950	8265′	Solution Gas.

Type Oil: Paraffin Base Sweet, Gravity—36° API, Viscosity—3.5 CP.

Type Reservoir: Anticlinal Structure.

Corrosion Problems: None.

Treating Problems: Heater treater at 120° + small quantities of chemical treating; is not considered a problem.

Paraffin Problems: Some paraffin, but insufficient to cause operating difficulty.

Remedial Work Programs or Practices: Sand-oil—good results. The best results have been with straight oil squeezes on the Dakota wells.

Treating: Originally most treating was done with steam coils inside gun barrels, temperature 120°. No mention was made of treating chemicals for earlier production. Now, treating is done with regular heater treaters operated at 120° with minor amounts of commercial treating compounds added ahead of the treater. Treating has apparently been no problem in Salt Creek. Large amounts of free water are produced with the Tensleep oil and is handled at the well site with a small "home-made" boot arrangement similar to a drip.

Corrosion: All types of corrosion have been negligible except for H_2S corrosion in Sundance wells. Several casing leaks have occurred in these wells.

Paraffin: Paraffin does not seem to be a problem in the producing operations at the present time. It is possible that it might have been earlier when gas in solution was breaking out.

Reservoir Drive: All reservoirs but the Tensleep and Third Sundance, produced originally under solution gas drive. The Tensleep and Third Sundance wells are still flowing as these reservoirs produce under active water drives. The Lakota had a delayed water drive—i.e., it now produces by this means.

Secondary Recovery: A gas injection program was instituted in the Second Frontier in 1927 after bottomhole pressure had dropped from 740 to 40 psi on top structure wells. After approximately two years of gas injection the rapid pressure decline had been halted and production decline restricted. All surplus gas has been returned to this reservoir. This project has been very successful as several million barrels of additional oil have been recovered as a direct result.

Gas was injected into the First Frontier but results were inconsequential.

A pilot water-flood had been started in the First Frontier on twin 10-acre and 5-acre spots. No results are available to date.

Big Horn Basin

The Big Horn Basin is an intermountain geographic and structural basin formed by the uplift of the following mountain ranges: The Big Horns to the east, the Owl Creek to the south, the Absaroka and Beartooth to the west and the central Montana uplift to the north. It includes Big Horn, Park, Washakie, Hot Springs

and a portion of Fremont counties in Wyoming and portions of Carbon, Stillwater and Yellowstone counties in Montana.

Geology. The early tertiary mountain building forces which raised the mountains surrounding the basin caused much faulting and folding of the Cretaceous and older sediments within the basin. Tertiary sediments from the erosion of the mountains were then deposited within the basin, thus covering the structure of the older beds. Subsequent erosion removed non-conforming tertiary cover from the older sediments around the rim of the basin and at the same time exposed the structures formed by the mountain building processes. The central portion of the basin is still heavily covered by these tertiary sediments which obscure the structure of the pre-tertiary sediments.

Early geologic exploration was confined to the outer rim of exposed older sediments where surface methods would delineate the desired structural features. It is but in the past decade and a half that geophysical exploratory methods have been used to search for buried structures in the central part of the basin.

A generalized stratigraphic section of formations in Big Horn Basin is presented in Table 3.

History of Exploration and Development. The history of exploration and development in the Big Horn Basin may be broken down into two distinct and separate phases. The first or early phase includes the period of great activity when structures visible on the surface were drilled in the search of light green Cretaceous oil and the accompanying discovery of heavy black sour crude in pre-Cretaceous formations. The second or present phase is the period of activity in developing the black oil reserves, the active deeper testing for black oil in known structures and the use of geophysical methods for the search of buried structures.

The first phase was initiated by the discovery of oil and gas in the Greybull and Garland fields in 1906 and 1907. These discoveries focused attention on the Big Horn Basin and led to intensive exploratory drilling. Light green oil was found in the Frontier sand in Elk Basin, Grass Creek and other fields. During the period 1906-1930 virtually all of the known structures were tested to the base of the Cretaceous in this search for the desirable crude. Some wells drilled to the Pennsylvanian rocks revealed the presence of black oil. This discouraged operators from drilling past the Cretaceous because the black oil could not be sold. Limitations of cable tool drilling also served to discourage deeper drilling.

From 1930 to 1940 interest in the Big Horn Basin waned because the known structures had been tested for green oil and were either producing or had been found to be dry.

The war time demand for petroleum products required the utilization of black oil to fulfill the demand; thus black oil fields in the Big Horn Basin were placed on production and exploration for new reserves was undertaken. This was the start of the second phase of activity within the Big Horn Basin. Since then there has been a constant increase in exploration for and development of black oil reserves. Now the Big Horn Basin contains the largest oil reserves of any major area in the Rocky Mountain Region and at the present is one of the largest producing areas.

Black oil production is obtained from the Phosphoria, Tensleep, Amsden, Madison and Big Horn. The major reserves at this time are in the Phosphoria and Tensleep. The Madison is productive in a number of fields and remains to be tested in many others. Two fields, Hamilton Dome and Garland, are producing from the Ordovician Big Horn which is practically untested in the other fields. The Darwin sand member of the Amsden is known to contain commercial reserves in a few localities but at present it is not being exploited. Recent development of production from the locally termed "Curtis" sand member of the Chugwater in the Grass Field is causing operators within the basin to examine this formation more closely.

Drilling and Completion. During the early phase of development of the light oil reservoirs the wells were shallow, 500 to 2500 feet. These wells were drilled with cable tools and completed by drilling to the top of the sand, and setting casing. Heavy shots of nitroglycerine were used to stimulate production.

Workover of these shallow wells consisted of simple clean-out with cable tools and re-shooting with nitroglycerine. Considerable success has been achieved with fracturing some of these old wells, but it must be undertaken with caution as the quality of the cement jobs on the casing is usually questionable.

Initial producing rates were high, followed by a rapid decline and then a long stabilized period of low production. Some operators installed compressors to inject and recycle the gas. Most of these plants are now shut down.

The present phase of activity was started by the deeper exploration of

TABLE 3

Age	Formation	Lithologic Characteristics	Thickness in Feet
Tertiary	Wasatch	Shales & sands, some coal	Varies
	Fort Union	Predominately sand w/interbedded shales	300— 800
	Lance	Sands w/interbedded shales	600— 700
	Meeteetse	Sands & shales	200— 300
Upper Cretaceous	Mesa Verde*	Sands & shales w/coal	800—1000
	Cody	Shale	1500—1800
	Frontier*	Well developed sand w/black shale between members	500— 700
	Mowry	Black shale	300— 500
	Thermopolis	Black to grey shale. Contains muddy sand member	450— 600
	Dakota*	Sand	40— 60
Lower Cretaceous	Fuson	Shale	200
	Lakota*	Conglomeritic sand	50— 100
Jurassic	Morrison*	Variegated shales & sand	150— 200
	Sundance	Sands & shales	350— 400
	Gypsum Spgs.	Massive anhydrites	50
Triassic	Chugwater*	Red Beds	1100—1300
	Dinwoody	Green limey shales	20— 120
Permian	Phosphoria*	Grey to black limestone & dolomite	20— 250
Pennsylvanian	Tensleep*	Sand, limey sand & limestone	200— 250
	Amsden*	Limestone, red shale w/basal sand	275— 350
Mississippian	Madison*	Grey to blue massive limestone	800—1000
Devonian	Three Fork	Red & Green shales	175— 200
	Jefferson	Brown & buff limestone	40— 50
Ordovician	Big Horn*	Massive limestones & dolomite	250— 300
Cambrian	Gallatin	Massive limestone shaley & base	500— 600
	Gros Ventre	Shales w/sands & limestones	400— 500
	Flathead**	Arkosic sandstone	175— 200

* Denotes formations that have produced or are producing oil and/or gas.
** Shows of oil have been reported.

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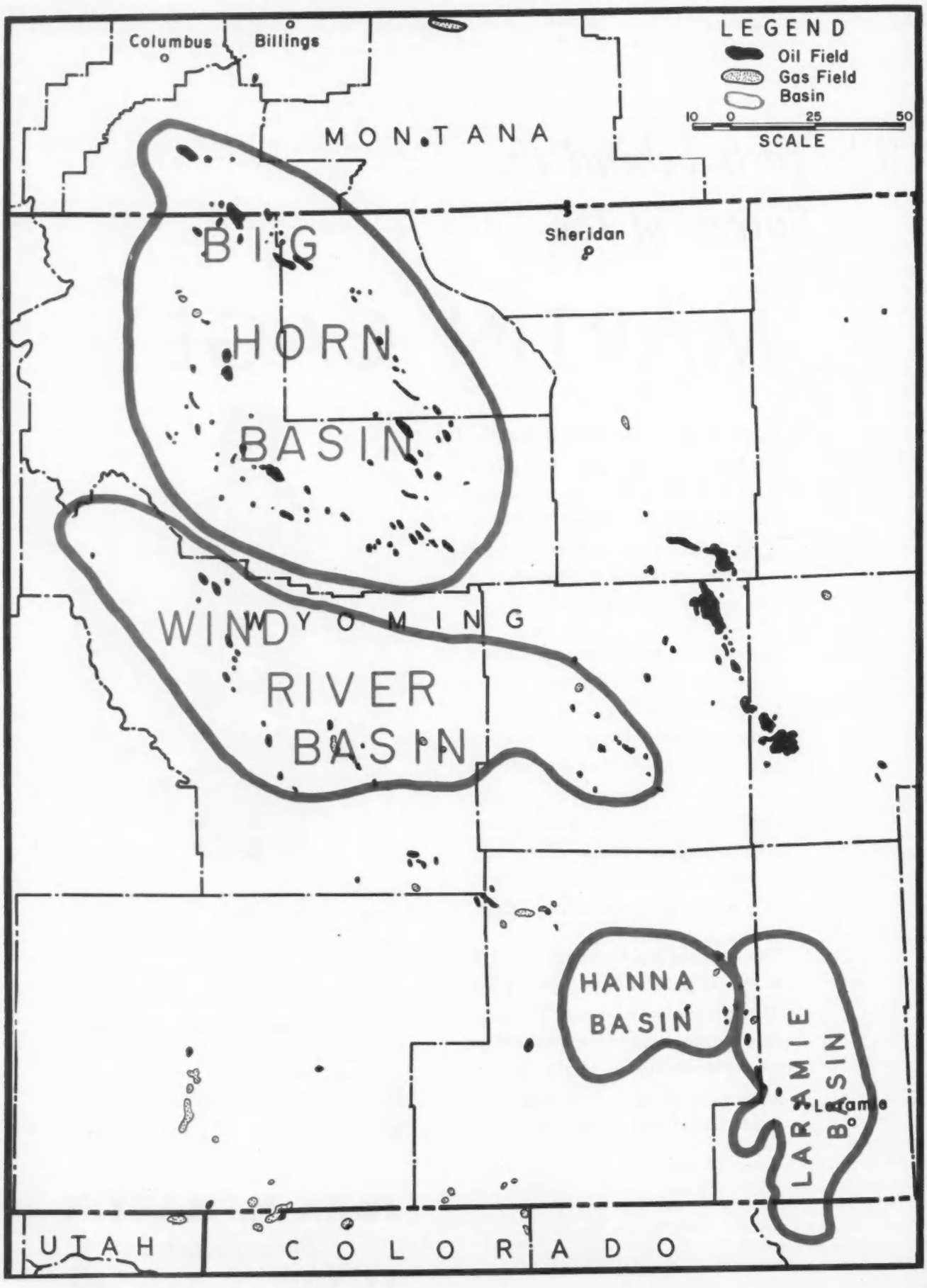
LEGEND
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SCALE
Columbus
Billings
MONTANA
Sheridan
BIG HORN BASIN
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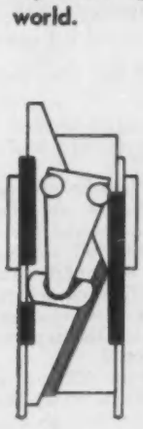

Fig. 1

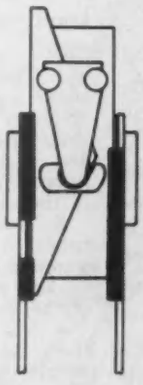

Fig. 2

Fig. 3

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known structures which had not been tested to the possible black oil horizons. Most of the untested known structures were held by operators already in the area; therefore, the operators who moved in when their interest was aroused were forced to seek more difficult prospects. This required the use of geophysical assistance.

Present drilling depths range from 3500 to 10,000 feet. Deeper wells are being drilled for exploratory purposes; however, few development wells exceed that depth. Rotary rigs are used almost exclusively for drilling. The formations encountered are considerably harder than in other portions of the United States. In common with the rest of the Rocky Mountain Region, penetration rates are lower.

There is a wide variation in completion practices among the various operators. Commonly used completions are:

- Casing set through the pay zones and perforated.
- Casing set on top of the pay and reduced hole drilled through the pay.
- Full gage hole drilled through the pay and casing swung and cemented at the top of the pay.

Most of the black oil producing reservoirs have an active water drive; therefore, more operators prefer to set pipe through and perforate because better control of water encroachment can be obtained by this method. The use of reduced hole below pipe is quite popular because zones of water entry may be located by use of open hole packers. Slotted liners or gravel packing to control sand are not used because the formations are competent.

Conventional electric logs give good correlation and permit quantitative interpretation for beds through the Cretaceous formations. More operators are preferring to use radioactivity logs or focused electric logs for correlations and quantitative interpretation of formations below the Cretaceous. This is because the dense zones in the lower formations tend to obscure the resistivity curves of the conventional electric log.

Workover in most of the black oil reservoirs is generally confined to locating and shutting off zones of water entry. This can present a complex problem where the viscosity of the oil is many times higher than the viscosity of the water.

Fracturing has become a valuable tool for production stimulation in sand reservoirs. Treatment volumes have varied from 1000 gallons to as high as 30,000 gallons but the excessively large jobs are the exception rather than the rule. Excellent results have been obtained with moderate volumes of 3000 to 5000 gallons. Common sand-oil ratios are one pound of sand per gallon. The use of additives to thicken the oil and to control fluid loss is becoming quite common. More operators are tending to use lease crude and additives as the remote location of the fields increases the high transportation costs.

Acid treatment is being applied successfully to limestone reservoirs. Treatments have ranged from a few hundred gallons to as high as 20,000 gallons. Some of the tight limestones require large volumes of acid to yield a commercial well. Retarded acid is being used in an increasing number of jobs. Excellent results are being reported on the use of this acid.

Producing Problems. Even though most of the black oil reservoirs are subject to an active water drive, the wells will not flow throughout the life of the well. This is because the original bottom hole pressure is usually less than hydraulic gradient. Standard pumping units are most commonly used. Subsurface pump life is long in most of the black oil operations because little or no sand is produced and the oil has natural lubricating qualities which effectively reduces the wear. Electric motors are prevalent for prime movers on pumping units.

The black crudes produced are generally sour; however, corrosion of subsurface equipment is not a great problem because most of the crudes appear to possess natural inhibitive qualities which keeps the corrosion at a minimum. Wells producing considerable volumes of water are corrosive and at times this can present a problem. Some of the sour crude being produced from the deep reservoirs is high gravity and contains large volumes of gas. Corrosion of subsurface equipment in such wells is much more severe than that experienced in the shallower lower gravity oils.

Flow lines from the wells to the tank batteries must be buried to protect them from the low temperatures commonly experienced. Most of the soils traversed by these flow lines are bentonitic and retain all moisture which falls in the disturbed earth of the ditch. This moist earth, containing large quantities of soluble salts, is extremely corrosive to bare steel pipe. Most operators are now cognizant of this fact and are taking steps to reduce or prevent this corrosion by applying protective coatings and/or cathodic protection.

Tank batteries are generally equipped with galvanized stock tanks as the combination of hydrogen sulfide and water vapor is extremely corrosive to unprotected steel.

Treating of crude oil presents some knotty problems for the following reasons:

1. The emulsions formed by oil and water are often stable and difficult to break.
2. Most of the water produced is fresh and oil gravity is low; therefore, there is little difference in specific gravity to assist in the separation of oil and water.
3. Most of the oils exhibit extreme tendencies to foam. This causes carry-over of water unless all gas is removed before the oil and water enter the separation section of the treating vessel.
4. Viscosity of the oils is generally high; this retards the rate at which the free water droplets may settle through the oil. Water will carry over if sufficient settling time is not provided.

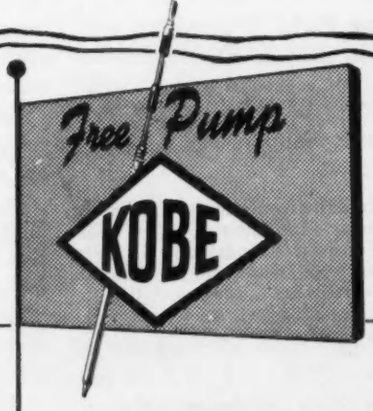
These problems are being solved by the following means:

1. Emulsion breaker chemicals are generally added to the well stream at the well head. Representatives of treating chemical manufacturers are extremely cooperative in assisting in the selection of the proper chemical to do the best job.
2. Tank manufacturers supplying the treaters are furnishing vessels which supply sufficient heat to the well stream so that gas is completely liberated before the crude oil reaches the degassing section of the treater; this minimizes the foaming condition.
3. Treating vessels are generally of sufficient oversize so as to provide sufficient settling time in the vessel and effect a complete separation of water from the oil.

All equipment that is handling water is designed, housed, or adequately protected to prevent costly freeze-up. Treaters are insulated to prevent wide fluctuations in temperature which would adversely affect the treating efficiency of the unit. The manufacturers provide treaters with inside syphon lines and control valves grouped so as to be housed in a minimum sized building. All water lines are buried below the frost line to eliminate the possibility of freezing. Where high viscosity oil is being handled, stock tanks are provided with heating coils to maintain the oil at sufficiently high temperatures as to render the oil pumpable.

One of the most perplexing prob-

There's a better, easier way to pump oil wells, too...



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lems is that some crudes do not contain sufficient gas to fire the treater or steam generator. This requires that some form of oil burner be used to supply the required heat. Two types of oil burners are in common use. One is a rotary burner which uses an electric motor driven fan to atomize a small stream of oil and blow it into the firebox of the vessel to be heated.

The other utilizes a jet of compressed air to atomize the oil and blow it into the firebox. Both types have the definite applications depending upon the gravity and viscosity of the crude and the vessel to be fired. In all instances pilot lights and safety controls are incorporated in the installation to provide safe and automatic firing.

Crude Oils Produced. The Cretaceous crude produced in the Big Horn Basin ranges from 40° to 48° API gravity, is paraffin base and green in color. It is a high grade crude and is much in demand by the local refineries.

The black oils are generally produced from the Chugwater, Phosphoria, Tensleep, Madison, Amsden and Big Horn. These crudes vary from heavy black viscous oil of 11° API gravity. All of the oils are high in sulfur content. The higher gravity oils generally have high producing gas-oil ratios and the lower gravity crudes have low gas-oil ratios.

The gas produced with these sour crudes is high in hydrogen sulfide content, varying from a fraction of a percent to in excess of 40 percent hydrogen sulfide. The high hydrogen sulfide content has resulted in innovations not common to the general oil producing areas.

Sulfur Extraction Plants. During the early producing life of the Elk Basin Embar-Tensleep reservoir, it became apparent that the water drive was not active enough to maintain reservoir pressure above the bubble point and if corrective measures were not applied, the reservoir would behave as a volumetric reservoir and recovery would be low. The solution to this problem was to provide some method of pressure maintenance.

Water drive was considered but rejected because of the high cost and limited supply of water available. Pressure maintenance with natural gas was out of the question because a sufficient volume of gas was not readily available. An inert gas pressure maintenance program was initiated.

The plan was to gather the produced gas and pass it through a processing plant where the hydrogen sulfide would be removed. The sweetened gas would then be burned under a boiler and the power produced would be utilized to provide electric energy for field use. The stock gasses would then be stripped of the water vapor and carbon dioxide leaving the nitrogen as a residue; this residue would then be injected into the formation for pressure maintenance.

It was further proposed that the hydrogen sulfide be processed to yield elemental sulfur. This plant has been in operation since 1949 and has resulted in maintaining reservoir pressure, in recovering much gasoline and liquefied petroleum gas and in recovering much elemental sulfur which has a ready market.

A second sulfur extraction plant was erected in 1950 at the Worland field to remove elemental sulfur from the sour gas and to deliver the sweetened residue to a public utility company.

The third plant built with similar objectives was installed at the Silvertip field in 1952. A fourth plant was built in 1954 to process gas produced from the Manderson field. It is understood that a fifth plant is being proposed to process sour gas from the Neiber Dome field.

Producing Fields. Day by day new discoveries are added to the list of producing fields within the Big Horn Basin; thus it is difficult to accurately count the number of fields producing petroleum. It is conservatively estimated that there are in excess of 70 fields operated by over 50 concerns within the Big Horn Basin at this time. This large and prolific structural basin is contributing greatly to the petroleum producing potential of the Rocky Mountain Region.

Wind River Basin

Circle Ridge Field. Discovery well was drilled in 1923. Development was slow until 1951. A total of 115 wells have been drilled to date and produce from 6 separate reservoirs in 4 formations as follows:

Overthrust Embar (Limestone)	44 wells
Subthrust Embar (Limestone)	16 wells
Overthrust Tensleep (Sandstone)	31 wells
Subthrust Tensleep (Sandstone)	17 wells
Madison (Overthrust) Limestone	6 wells
Darwin Sand	1 well

The crude oil from all reservoirs is approximately 23.5° API, black oil, with 2 cubic feet per barrel solution gas. Viscosity of oil is 59 Cp.

The fact that the oil from all reservoirs has the same characteristics has caused some thought that all reservoirs are producing from a common source.

The producing formations have steep dip with oil being trapped against a high angle thrust fault. Production from the various reservoirs varies from 200 to 1800 feet. Apparently the oil water contact is found at approximately the same depth in most reservoirs, again indicating communication between reservoirs.

All reservoirs are highly faulted. This condition, coupled with the active water drive and high viscosity oil, creates serious by-passing of oil. The problem of determining best method and most efficient rate of production is extremely complicated.

The fracture condition also causes serious lost circulation while drilling and difficulty in getting a good cement job on casing.

An interesting feature of the field is that the Embar formation outcrops at the surface 600 feet from a well that produces from the Embar.

An interesting operational problem is the burning of crude oil in boilers to furnish steam heat for treating oil and for heating houses.

Maverick Spring Field. Discovery well was drilled in 1918. Now has 17 producing wells (16 Embar and 1 Tensleep). Water production is high. Two additional Embar wells are temporary shut in. Black, 23° API oil. Producing depth ranges from 1400 to 1800 feet. Reservoirs are fractured. A few attempts have been made to plug back and shut off water with little success. Crude oil is burned in a boiler to furnish steam for gun-barrels.

The Dallas Field is unique in several respects. It is credited with the first commercial oil well drilled in Wyoming, although some drilling activity was going on in the Shannon Pool at the north end of the Salt Creek field at the same time. The Mormons had produced oil from natural oil springs

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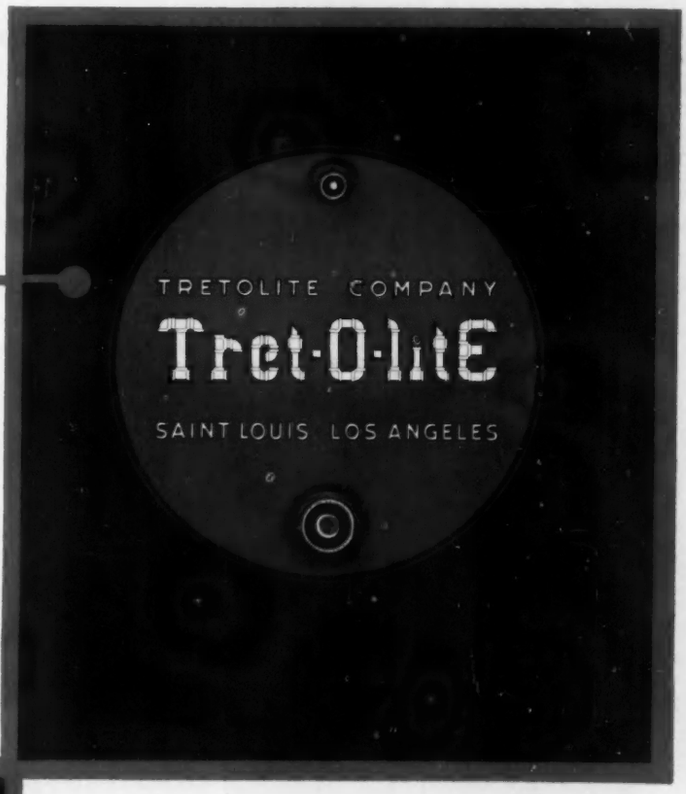

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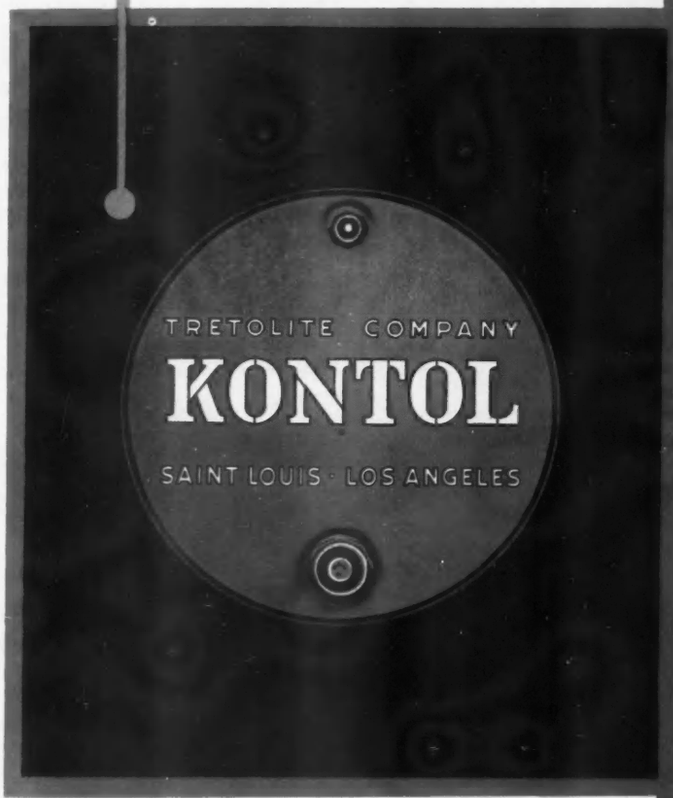

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in southwestern Wyoming prior to 1850.

The field also has produced more oil per acre than any other black oil field in the state. The producing area is very small and limited to about 90 acres; the production has been about 41,000 barrels per acre from this area.

The oldest oil field in Wyoming and one of the shallowest still has untested deeper prospective horizons.

The Dallas field is located in Fremont County, Wyoming, about 10 miles southeast of Lander, just east of the Lander-Rawlins highway.

Geology and Structure—Dallas Dome is a local high on the Lander anticline, which is a long asymmetric fold in the southwestern part of the Wind River Basin about six miles distant from and parallel to the Wind River Mountain front.

Dips on the west flank range from 60° to 90° and from 10° to 30° on the east flank. A small area at the crest of the dome is relatively flat.

It is separated from Derby Dome at the southeast by a shallow syncline and from Lander-Hudson Dome to the northwest by a much deeper syncline. The limiting closure at the southeast end is about 1000 feet.

History and Development—The first producing oil well in Wyoming was drilled in the Dallas field in 1884. This well though now abandoned produced until a few years ago and appropriately still bears the number one. It was completed to produce black oil from the Chugwater formation at a depth of about 300 feet. Well No. 1 was located squarely in the center of an asphalt deposit covering about a half acre which had resulted from a live oil seep. As it happens this location is also about as squarely on the exact crest of the dome as can be imagined.

Within two years following discovery, several additional wells were drilled and well No. 3 was drilled deep enough to make a discovery of oil in the Embar at 750 feet. Well No. 3 is still producing after 61 years.

In 1927, well No. 31 was deepened and made a discovery in the Tensleep sand, which underlies the Embar formation. A total of 60 wells have been drilled in the field of which 21 are listed as producing. Thirteen are producing from Embar and Tensleep and eight are producing from the Embar alone. All Chugwater wells have been abandoned.

Long Creek Field. Field has one gas well completed in Embar at 5400 feet. Potential of well is 2 million cubic feet per day. An Ammine plant was installed to extract H_2S from gas.

This well is interesting because it is unusual for the Embar formation to produce gas.

Riverton Dome Field. The field has seven wells as follows: Two wells are completed in the Phosphoria as gas-distillate wells. 57° API gravity distillate, GOR 19,000 cubic feet per barrel. Producing depth, approximately 11,500 feet. Formation is 300 feet thick.

Four wells are completed in Tensleep and produce 46° API black oil. GOR 1200 cubic feet per barrel. Approximate producing depth is 12,200 feet. Formation is 300 feet thick.

One shut-in gas well in Frontier formation. Estimated potential 4,000,000 cubic feet per day.

All wells flow. One well is being considered for a Kobe pump. All wells were drilled through the Tensleep with two wells being plugged back to the Phosphoria. The field was developed in 1948.

A desulfurization plant is being considered with a 2,500,000 cubic feet per day capacity.

Hydrogen sulfide corrosion causes embrittlement of the tubing. Special alloy tubing is being evaluated for installation in the wells.

The Tensleep wells have been treated with sand-oil squeeze with good results.

South Sand Draw Field. The field is producing, one well drilling, and one well temporarily abandoned.

The producers are completed in the Phosphoria at a depth of 8200 feet. Pay thickness is 40 feet. The Tensleep (depth of 8600 feet) is productive, but is not produced. Tensleep pay is 40 feet thick.

The first well was drilled in September 1953. The Phosphoria produces 36° API black oil with a small amount of hydrogen sulfide gas.

The Phosphoria has been treated with small oil treatments with good results.

Trouble is encountered with scale in the treaters. A program is being initiated to use pellets in an attempt to control scaling. The pellets will be "slugged" into the casing annulus.

Frontier is thought to be a possible gas producer.

Steam Boat Butte. A long assymetric fold on the west flank of the basin. The west side is steep, dipping from a fault zone. The field was discovered in 1943.

Producing Zones

Age	Formation	Production
Cretaceous	Frontier	gas
Jurassic	Nugget	oil 27° API, sour
Permian	Phosphoria	oil black, sour, 32° API.
Pennsylvanian	Tensleep	oil black, sour, 29° API.

Producing problems—None of any consequence. All formations have some water drive but not active. The sour crude contains some hydrogen sulphide and there is minor corrosion problems present. Remedial work in the form of plug back jobs with cement has been moderately successful.

Acidizing to increase production or clean up the well has been successful.

Pressure Maintenance—The Tensleep reservoir has a limited water drive and to hasten recovery fresh water from the Wind River is injected into the reservoir around the periphery. This has been highly successful in maintaining pressure.

Sand Draw Field. A long narrow steep sided anticline trending nearly north and south, faulting in upper formations paralleled the axis and complicate the structural picture. Discovered in February 1918 this field is along the SW flank of the basin.

Producing Zones:		
Upper Cretaceous	5 Frontier Sands	gas
	Dakota	gas
Jurassic	Morrison	gas
Permian	Phosphoria	sour gas and distillate
Pennsylvanian	Tensleep	Black oil 40° API, slightly sour

Producing Problems—Gas is delivered to Northern Utilities, some distillate produced and sold to pipe line. The Tensleep oil contains hydrogen sulfide gas and there is some minor corrosion in tanks. This reservoir is a 300 foot thick, soft, porous, sand and very little remedial work is necessary. An active water drive in this formation means that recovery will be good and it is one of the larger oil reserves in Wyoming.

Produced crude is treated in heater treaters and with chemicals if needed. Well completions either set on top of the sand or set through and perforate.

Some development drilling of the Tensleep reservoir is continuing, how-

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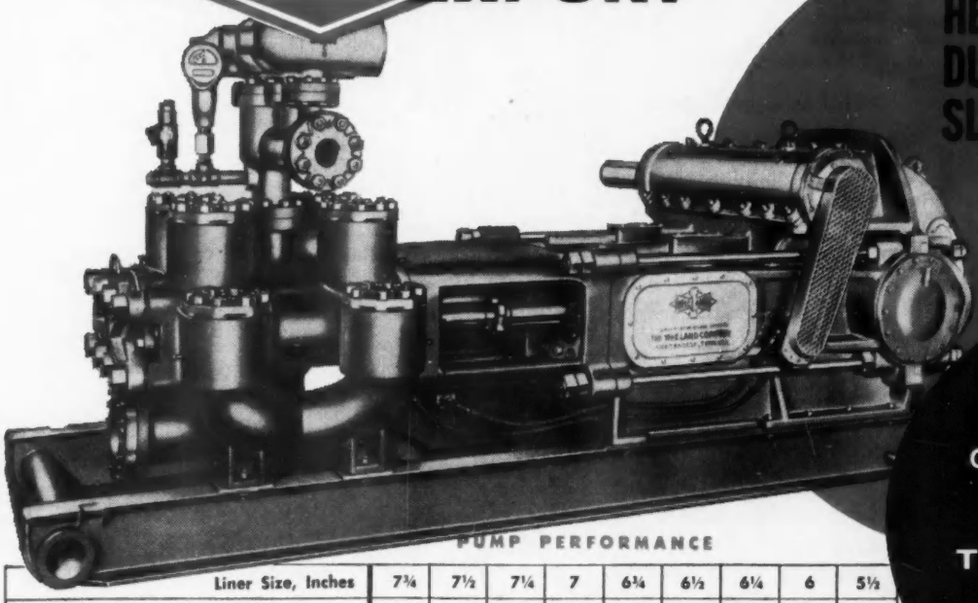

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Speed of Crank RPM	Pump Horsepower Rating		Output in U. S. Gallons per Minute Pumped at 100% Volumetric Efficiency								
	Input	Output									
60	750	638	826	770	716	663	613	564	517	472	388
55	689	585	757	706	656	608	562	517	474	433	355
50	626	532	688	642	597	553	511	470	431	394	323
45	563	478	619	577	537	497	460	423	388	354	291
40	500	425	550	513	477	442	408	376	345	315	258
35	438	372	482	449	417	387	357	329	302	275	226
1			13.77	12.84	11.94	11.06	10.22	9.41	8.63	7.83	6.47

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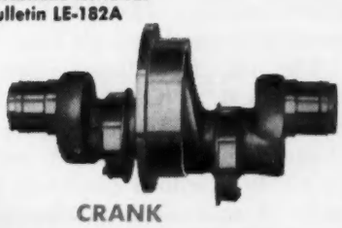

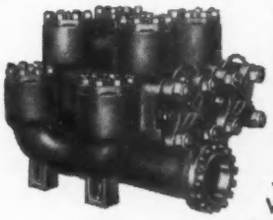

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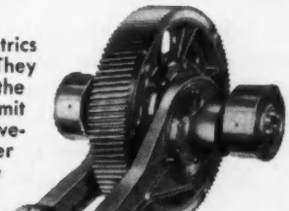

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ever, the reservoir is nearly developed.

The Madison, next possible deeper pay zone has been tested and found water bearing.

BEAVER CREEK FIELD

Formations and depths:		
	Mesaverde	3500
	Frontier	7000
	Muddy	8000
	Lakota	8300
	Tensleep	10,500
	Madison	11,000

Crude Characteristics: Mesaverde is sweet, green, 39° API. Frontier, Muddy, and Lakota are gas distillate. Tensleep is sour, green, 40° API. Madison is brown, slightly sour, 40° API.

Drilling Problems: High pressure gas sands and extremely hard formations at red beds and below.

Corrosion Problems: Condensate in gas wells H_2S corrosion in the Tensleep.

Paraffin Problems: Paraffin in the flow lines of Mesaverde and Tensleep wells.

Remedial Work: Sand-Oil Hydrafrac for Mesaverde gas sands, and Tensleep. Acidize the Madison.

Logging Methods: Electric Log and Microlog.

Type Reservoir Mechanism: Mesaverde; water drive. Gas sands and Tensleep: Volumetric. Madison: water drive.

Secondary Recovery: None.

Winkleman Dome.

Formation and depths: Phosphoria, 3500; Tensleep, 3700.

Crude Characteristics: Phosphoria is black, 24° API; Tensleep is black, 24° API.

Drilling Problems: None.

Corrosion Problems: None evident.

Paraffin Problems: None.

Remedial Work: Acid in Phosphoria. Some plug back for water shut-off in the Tensleep.

Logging Methods: Electric and Microlog.

Type Reservoir Mechanism: Phosphoria; Volumetric, Tensleep; water drive.

Secondary Recovery: None.

HUDSON-LANDER FIELD

Formation and depth: Phosphoria, 2100; Tensleep, 2300.

Crude Characteristics: Phosphoria and Tensleep are both black, 23° API.

Drilling Problems: High pressure water in basal Tensleep. Some lost circulation.

Corrosion Problems: Slight amount of sulfate corrosion.

Pariffin Problems: None.

Remedial Work: Acid and acid-frac in Phosphoria. Plug-back for water shut-off in the Tensleep.

Logging Method: Radioactive Log.

Type Reservoir Mechanism: Phosphoria; Volumetric. Tensleep; water drive.

Secondary Recovery: None.

Uinta Basin

THE UINTA BASIN is a sedimentary basin located in northeastern Utah, covering an area of approximately 9000 square miles. The basin is bounded by the following structural features:

The Uinta Mountains on the north, the Wasatch Mountains on the west, The San Rafael Swell on the south, the Uncompahgre Uplift on the southeast, and the Douglas Creek Arch on the east. The center of the Basin is downwarped and filled with approximately 12,000 feet of sediments of many lithologic types.

The two formations which have been found to be productive in this area, are the Wasatch and Green River formations. The Wasatch is primarily a redbed consisting principally of shales and sandstones. The Green River formation primarily consists of shales, sandstones and limestones.

The first commercial oil of the basin was discovered in the Roosevelt field in 1949 and produced from a fractured zone near the base of the Green River formation.

With the exception of Duchesne County crude, the produced oil has an exceptionally high paraffin content, 15 to 40 percent with a gravity ranging between 30° and 43° API and a pourpoint of 90° to 100° F. Gravity of Duchesne County crude is 23.5° API with a pourpoint of 30° F.

Considering the comparatively few test holes which have been drilled and the number of gas and oil shows which have thus far been encountered a far greater number of oil and gas fields in all probability lie in the future of the Uinta Basin. When the problems involving high drilling costs, pipe line transportation, and high paraffin wax content are solved, activity in the Uinta Basin should increase substantially.

Rangely Field located on the northern end of the Douglas Creek Arch in Rio Blanco County, Colorado has Mancos shale varying in thickness from 3000 to 4200 feet occupying the surface of the structure. In 1902, shallow production from 500 to 1700 feet was encountered in fracture zones in the Mancos shale.

The Dakota sandstone which is approximately 100 feet in thickness, has yielded gas in several wells together with a show of oil in at least one well, but both gas and oil were rapidly watered out.

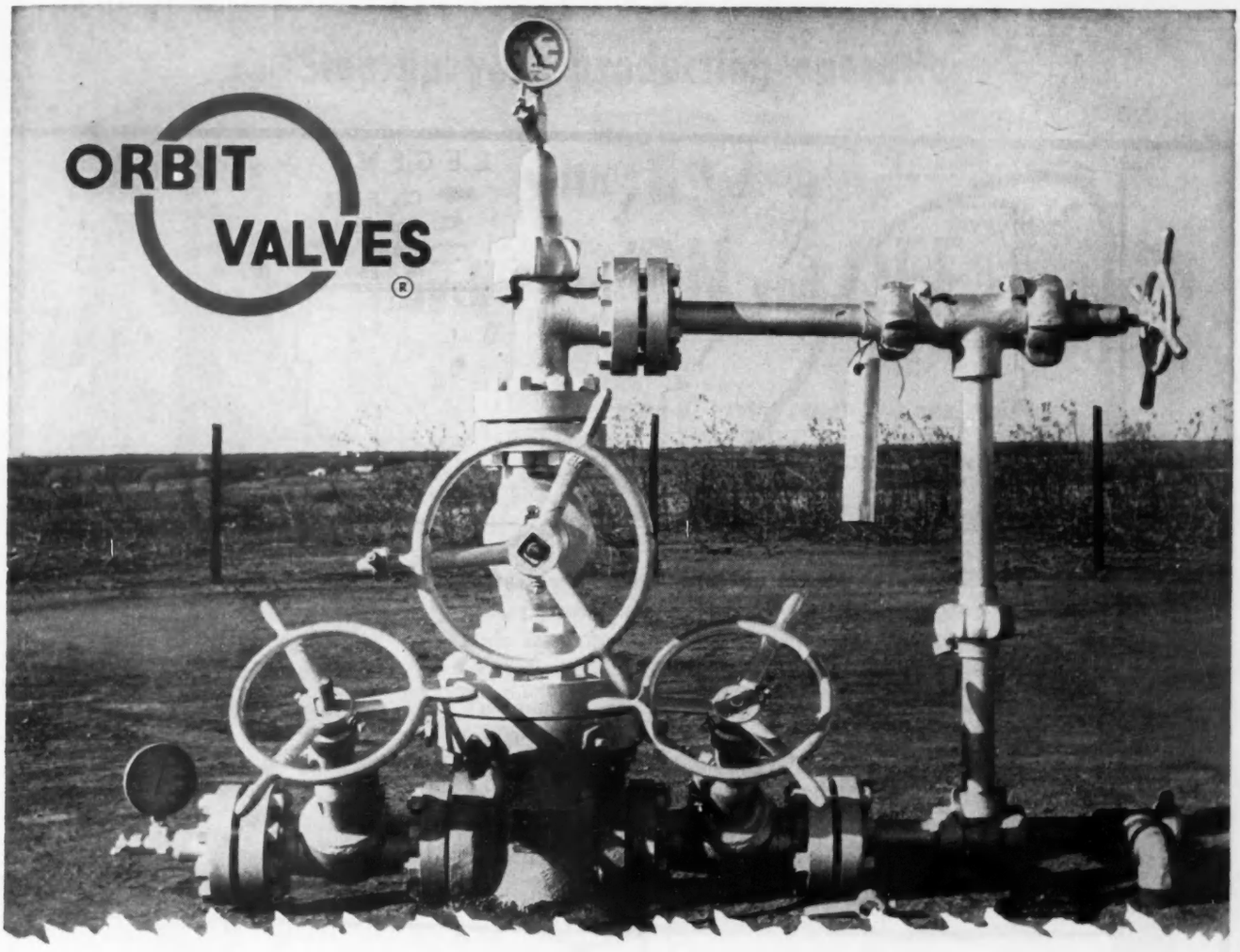
The Morrison formation consisting of approximately 450 feet of varicolored shales underlain by 250 feet of lenticular beds of sandstone had shows of gas and oil.

Underlying the Curtis, Entrada, Carmel and Navajo formations are the so-called redbeds, aproximately 900 feet which probably includes the Chinle, Shinarump, Moenkopi and Phosphoria formations. Continental Oil Company's Rooth No. 2 well was completed in the Shinarump conglomerate in 1946 and is the only well in the field which has yielded high gravity oil in commercial amounts from that formation, although heavy black oil shows have been encountered in the conglomerate in several wells.

Below the Phosphoria lies the Weber sandstone, the principal oil-bearing formation in the field. The Weber occurs at depths ranging from approximately 5500 feet to 6600 feet depending upon position on the anticline. The Weber formation consists of a fine-grained, gray sandstone interbedded with thin beds of red shale and is approximately 1200 feet in thickness. Sections of the Weber produce from the upper 700 feet of the formation. Much of the sand is highly impermeable although considerably saturated with oil.

During 1933, the California Company completed the first flowing well in the Weber sandstone with an initial production of 300 barrels of 31° gravity oil per day. During the years 1945-49 a total of 480 Weber wells were completed and in 1948 a ten-inch pipe line was laid from Rangely to Salt Lake City and to Wamsutter, Wyoming. Possibilities of deeper production have been considered. However, in 1953 the Texas Company-Union Pacific Railroad, in drilling to the Cambrian Quartzite at 9360 feet, failed to encounter commercial production below the Weber sandstone. The promise of deeper production however, has not been dimmed by this single unsuccessful test, since a sedimentary section consisting chiefly of marine beds, approximately 2000 feet thick, is present below the Weber. Further testing is feasible if not imminent. A shifting axial plane, together with subsurface faulting in the Rangely Dome, create possibilities of future consideration both in the Morgan and Madison formations.

Table 4 reviews the more important characteristics of the three formations presently producing the Rangely anticline.



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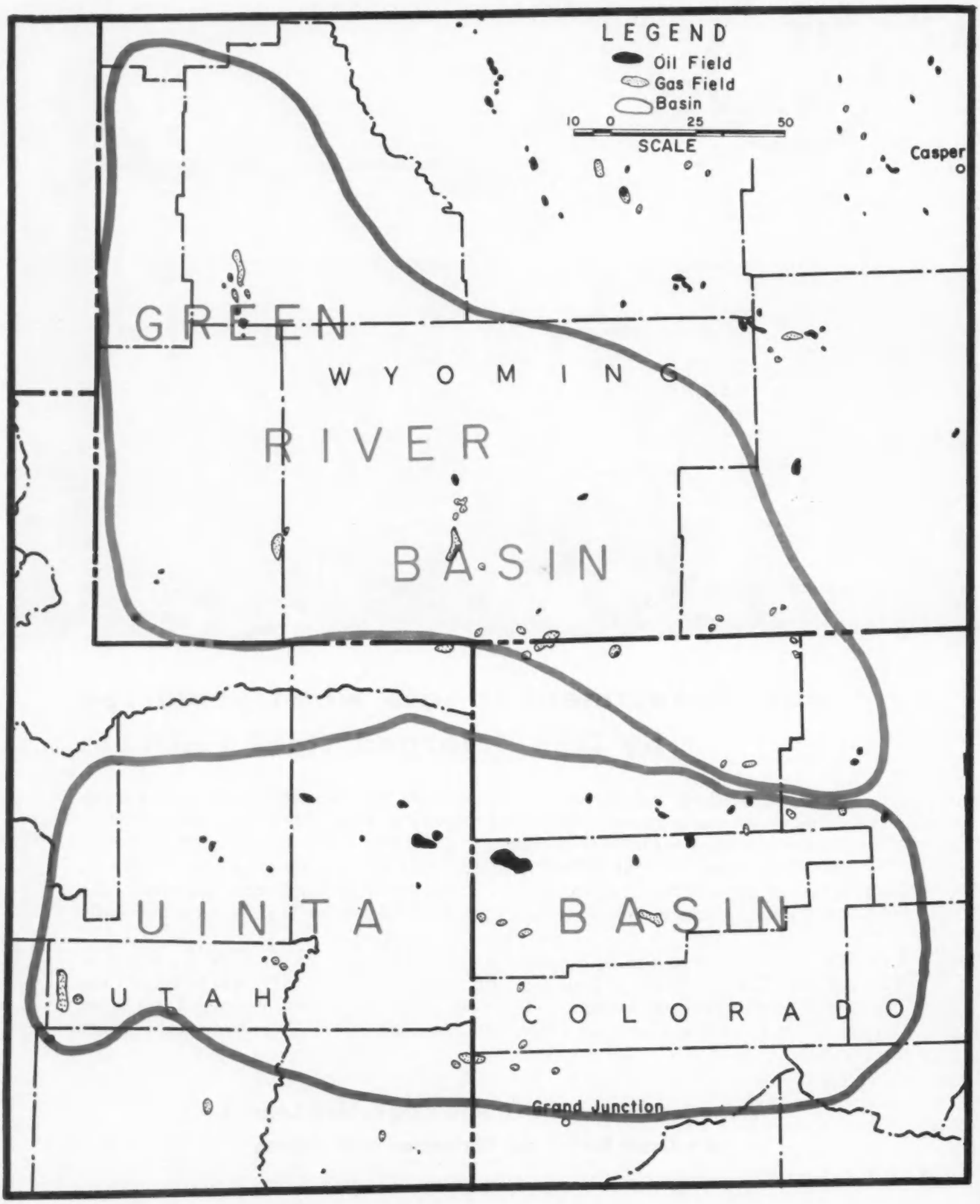
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TABLE 4

Pay Zones	Typical Core Anal.	Structure	Physical Prop. Oil	Initial Field Press.	Type Drive	Completion Practices
Weber Sandstone	Por.=16% Perm.=20 md SW=20% SO=20%	Anticline	Grav.=35° API Sulfur=0.70% Pourpoint=40° F. Mixed base	2750 psi.	Gas Cap Expansion & limited water drive	7" csg. set above Weber formation
Shinarump Conglomerate	No cores	Strat. pinchout on flank of anticline	Grav.=38.5 API Sulfur=0.52% Pourpoint=45° F. Mixed base	Unknown	Expansion solution gas	Csg. set above Shinarump formation
Mancos Shale	No cores	Fractures	Grav.=52° API	0 psi	Liquid expansion	Csg. set above prod. zone

TABLE 5

Pay Zones	Typical Core Anal.	Structure	Physical Prop. Oil	Initial Field Press.	Type Drive	Completion Practices
Dakota-Lakota Sandstones	Por.=15% Perm.=50-1675 md SW=25% SO=0	Anticline	Sp. Grav.=0.631 BTU=950 Sulfur=0	1600 psi	Gas	Csg. cemented thru productive zones and perf.

The gas produced in the Rangely field is presently being returned to the Weber sand in an effort to increase ultimate recovery from that formation.

Rangely Productivity Measures. During the past seven years, a great deal of formation fracturing has been used to stimulate Welso Sand production. Formational fractioning has been by shooting, hydrafrac treatment, oil-squeeze, and sand-oil treatment.

The first hydrafrac treatment in the Rangely field was performed in June, 1948 with a resulting increase in production of 26 percent. This successful treatment encouraged additional hydrafrac stimulations which resulted in an average production increase of approximately 40 percent. The total number of hydrafrac treatments performed in the field reached 12 prior to the advent of oil-squeezing in 1950.

During April, 1950, the first selective oil squeeze treatment was performed. To 1955, a total of 343 oil-squeeze treatments have been performed. During the past two years, 1953 and 1954, production increases ranged from 5 percent to 468 percent using from 75 to 1100 barrels of oil pumped at pressures ranging between 400 to 2400 psi.

The initial sand-oil treatment was performed in February, 1953. During 1953 and 1954 a total of 153 sand-oil treatments achieved production increases varying between 11 percent and 3450 percent. The amount of oil used varied between 500 and 25,000 gallons while the amount of sand used varied between 500 and 30,000 pounds with the general practice of using a sand-oil ratio of 1.0. Pumping pressures varied between 250 psi and 3400 psi.

The foregoing production stimulation treatments were performed in intervals ranging in depth from 5500-6900 feet. In view of the majority of highly successful formational fracturing treatments which have been performed in the Rangely field, little doubt remains as to the beneficial results of hydraulic fracturing the Weber sandstone.

Douglas Creek Field, located upon the crest of the Douglas Creek Arch in Rio Blanco County, Colorado, had gas discovered in 1943 from the Dakota-Lakota formation. Three benches of the Dakota-Lakota sandstones, ranging between 90 and 140 feet thick, are productive. Gas shows have also been encountered in the Mancos shale in the approximate intervals 350-400 feet and 3050-3350 feet; the Morrison formation in the intervals 4450-70 feet and 4820-30 feet; and the Entrada sandstone in the interval 5080-5100 feet. One well, the Douglas Creek Unit 1, has been drilled to the Devonian formation at 8442 feet, but failed to encounter commercial production below the Dakota-Lakota sandstones. Extensive faulting, evident in the Mesa-Verde formation, which overlies the Douglas Creek anticline in all probability, extends through the Morgan and Madison formations thus presenting the possibility of deeper production. Future deep exploration is not being considered at the present time, although it would seem that the structure has unexplored possibilities worthy of future consideration.

Table 5 summarizes the characteristics of the formations presently producing in the Douglas Creek field.

The Douglas Creek Unit 1 has recently been shut in due to high water production. High withdrawal rates during the past winter are believed to have caused either natural water encroachment or saturation of the productive formation with water emerging from plugged-off zones below the Dakota-Lakota formation. Recent remedial work consisting of cement squeezes have been unsuccessful in shutting off water production.

Iles Dome. Surface outcrops caused the Iles Dome anticline to be recognized as a possible oil productive structure during the early period of oil exploration in the Rocky Mountain region. Located in Moffat County, Colorado, the field is situated upon the southeastern end of the Axial Basin Anticline. The structure consists of a closed anticline with 500 feet of closure.

The first well drilled on a flank of the structure, resulted in a dry hole in 1918. The well encountered shows of gas in the Mancos shale together with water in the Frontier sand. In 1924, a well drilled high on the structure, was completed in the lower Mancos shale with an estimated potential of 1100 BOPD. In 1927, a well encountering gas and oil shows in the Morrison formation, was completed for an initial potential of 1900 bopd in the Entrada formation. In 1946, Stanolind Oil and Gas Company drilled a deep test to the Madison formation at a total depth of 7487 feet. Oil shows were encountered in the Weber formation, however the lack of formation permeability resulted in unsuccessful attempts to complete the well in this section. Fresh water was recovered as a result of a drill stem test of the Shinarump formation.

Four shallow wells were originally completed in the lower Mancos formation, but were abandoned due to excessive water production. Present production is from the Morrison and Entrada formations.

Table 6 summarizes information dealing with formations pressently producing in the Iles Dome field.

At the present time both the Morrison and Entrada formations produce large amounts of fresh water with the oil; in some cases as high as 98 percent are being economically produced.

Moffat Dome structure, a closed anti-

TABLE 6

Pay Zones	Typical Core Anal.	Structure	Physical Prop. Oil	Initial Field Press.	Type Drive	Completion Practices
Morrison Sandstone	No cores	Anticline	Grav.=31.5° API Sulfur=0.10% Pourpoint=30° F.	1248 psi	Water	Core or drill thru sand, run E.S. & Micro logs,set csg. 2-5′ into sand.
Entrada Sandstone	No cores	Anticline	Grav.=31.5° API Sulfur=0.10% Pourpoint=30° F.	1485 psi	Water	Drill 45-50′ into sand, run E.S. & Micro logs,set csg. 2-5′ into sand.

TABLE 7

Pay Zones	Typical Core Anal.	Structure	Physical Prop. Oil	Initial Field Press.	Type Drive	Completion Practices
Mancos Shale	No cores	Anticline	Paraffin Base	450 psi	Liquid Expansion	Run csg. thru pay zone, perf. uncemented csg.
Dakota Sandstone	No cores	Anticline	Grav.=37.8° API Sulfur=0.1% Paraffin Base	Unknown	Water	Csg. set on top Dakota. E.S. & Gamma Ray-Neutronlogs run on only one well in field.
Morrison Sand Beds	No cores	Anticline	Grav.=31.0° API Sulfur=0.1% Pourpoint=30° F.	Unknown	Water	Csg. set top of Morrison, open hole below.
Entrada Sandstrone	Por.=17% Perm.=20 md SW=40% SO=20%	Anticline	Grav.=38.8° API Sulfur=0.29% Paraffin Base	1600 psi	Water	Csg. set top of Entrada, open hole below.

TABLE 8

Pay Zones	Typical Core Analysis	Structure	Physical Prop. Oil	Initial Field Press.	Type Drive	Completion Practices
Morrison Sand	Por.=19.4% Perm.=11 md SW=44.6% SO=11.4%	Anticline	Grav.=49° API	2180 psi	Water & Gas	Morrison cored. E.S., Micro & Gamma Ray-Neutron logs run. Csg. set thru pay zone & perforated.
Entrada Sand	Por.=19.7% Perm.=35 md SW=35% SO=19%	Anticline	Grav.=48° API Mixed Base	2180 psi	Water	Drill or core approx. 100′ into formation. E.S., Micro & Gamma Ray Neutron logs run. Set csg. thru oil-water contact & perf. At later date will squeeze off and complete in Morrison.

cline located in Moffat County, Colorado on the southern end of the Williams Fork Anticline, includes approximately six square miles, but all production from the field is restricted to an area of approximately one-half square mile.

The discovery well drilled by Texas-Transcontinental Oil Company in 1923, encountered oil in two zones of the Mancos shale. Testing of the two zones recovered 41 bopd for the shallow zone and 125 bopd for the deeper zone. In 1924, the well was drilled to the Dakota in which the upper 20 feet of sand tested 4500 bopd. This discovery well continued to flow until 1925 when water cuts killed the well. Remedial measures failed and after producing approximately 430,000 barrels of oil, the well was abandoned. In 1928 oil was discovered in the Entrada formation and during 1948, a commercial discovery was made in the Morrison formation. Wells drilled to the Mancos and Shinarump formations encountered commercial quantities of oil during the years 1953-54.

Table 7 indicates a number of the characteristics of the various productive formations in the Moffat Dome field.

The Morrison and Entrada formations both have exceptionally active water drives which are quite advanced. Consequently, water cuts are exceedingly high, amounting to approximately 98 percent. The problem of water disposal is practically nonexistant since the water is fresh and uncontaminated.

The Wilson Creek Field is located on the south flank of the Axial Basin Anticline in Rio Blanco County, Colorado. In 1938, the Texas Company drilled the discovery well which encountered a commercial oil zone in sands of the lower Morrison formation and the Dakota formation. During 1941, the Texas Company drilled a deep test to the Cambrian Quartzite at 12,702 feet, which resulted in a discovery in the Entrada formation and a show of oil in the Weber formation. No other shows of production were encountered below the Morrison formation. The Weber formation was found to contain little if any permeability and future possibilities of production from this sand seem remote.

Table 8 summarizes the more important aspects of the Wilson Creek field.

One of the more important production problems in this field is the accumulation of paraffin in tubing and flow lines. Paraffin scrapers are used within the tubing together with chemical treatment for clearance of flow lines.

At the present time, a secondary recovery program consisting of gas injection into the Morrison sand is being profitably carried out, and gas injection into the Entrada sand is being studied.

Elk Springs Field located in the Axial Basin, on the northern end of the Douglas Creek Arch in Moffat County, Colorado, has a faulted anticline, upon which the first exploratory well was drilled by Union Oil Company in 1925. Drilled to 4000 feet in the Morrison formation, it was plugged and abandoned after encountering no shows of oil or gas above this point. In 1946, Continental Oil Company recovered commercial amounts of oil upon drilling to the Weber sandstone. Initial production from the Weber discovery was estimated to be 200 bopd. At the present time, three producing wells and three dry holes compose the total fields development.

Table 9 presents pertinent information dealing with the Elk Springs field.

A great deal of salt water is being produced with the oil. Salt water disposal is accomplished by evaporation.

Tow Creek Field. Tow Creek structure, located upon the southeast flank of the Sand Wash Basin of northwestern Colorado in Routt County was discovered by The Texas Company in 1924. The discovery well was drilled on the basis of surface geology and was completed in the Niobrara shale for an initial potential of 130 bopd. At the present time, all produc-

TABLE 9

Pay Zones	Typical Core Analysis	Structure	Physical Prop. Oil	Initial Field Press.	Type Drive	Completion Practices
Weber Sandstone	Por.=4.9% Perm.=1.9 md SW=12.6% SO=14.2%	Faulted Anticline	Grav.=30° API Asphalt Base	2400 psi	Water	Csg. set top of Weber. Sand shot with nitro.

TABLE 10

Pay Zones	Typical Core Analysis	Structure	Physical Prop. Oil	Initial Field Press.	Type Drive	Completion Practices
Niobrara Shale	No cores	Fractured Shale on Anticline	Grav.=36° API Sulfur=0.1% Pourpoint=10° F. Paraffin Base	Unknown	Gas	Csg. set top of pay zone. Drill into formation w/ cable tools. No electric logs run.

TABLE 11

Pay Zones	Typical Core Analysis	Structure	Physical Prop. Oil	Initial Field Press.	Type Drive	Completion Practices
Green River	Por.=5.5% Perm.=1.06 md	Anticlinal nose	Grav.=33° API Sulfur=0.1% Pourpoint=90° F. Paraffin Base	4481 psi	Solution Gas	Run E.S., Micro & Radio-activity logs. Set csg. above 1st pay zone.

TABLE 12

Pay Zones	Typical Core Analysis	Structure	Physical Prop. Oil	Initial Field Press.	Type Drive	Completion Practices
Green River Sands	Por.=12% Perm.=6500 md	Anticlinal nose	Grav.=30° API Pourpoint=90° F. Paraffin Base	2000 psi	Solution Gas	E. S., Micro, radio activity logs run. Csg. set thru formation & perf.

tion in the field is obtained from fractures in the Niobrara shale. In passing, it is of interest to note that the first rotary well in Colorado was drilled in this field. Two deep tests to the pre-Cambrian encountered a show of oil in the upper Morrison and water in the Entrada and Weber formations. Current drilling activity and extension of the producing area is based along the trend of fractures rather than along the structural axis. The basis for this course of development can be observed from iso-initial potential maps which parallel the fracture trends.

Table 10 includes a summary of information dealing with the Tow Creek field.

Piceance Creek Field. The Piceance Creek Anticline is located in the Piceance Basin of Rio Blanco County, Colorado. Gas was discovered during 1930, by the White Eagle Oil Company in the Green River formation at a depth of approximately 3000 feet. Initial potentials of development wells vary from two to 13 million cubic feet of gas per day. A deep test drilled by General Petroleum Corporation in 1946, reached the Mesa Verde formation at approximately 12,000 feet. However, no shows were encountered below the Green River formation. At the present time, all wells are shut-in awaiting an outlet for produced gas.

White River Field. The White River Dome is located at the northern end of Piceance Basin in Rio Blanco County, Colorado. The discovery of gas at a depth of 500 feet in the Wasatch formation during 1890, has encouraged periodic drilling activity consisting of eight completed wells. Initial potentials of these completions vary between two and 15 million cubic feet. Early completions produced a small quantity of light oil. A deep test in the area reaching a TD of 8500 feet in the Mancos shale, encountered a promising show of gas and oil in the Mesa Verde formation. The field is presently shut-in due to the lack of production outlet facilities.

Roosevelt Field, located in the northern portion of the Uinta Basin, was discovered in 1949 by The Carter Oil Company and Stanolind Oil and Gas Company.

The field, situated upon an anticlinal nose, is completed in the Green River formation. The producing horizon is a tight, fine-grained, limey sand which occurs between 9200 and 10,000 feet in depth. Production is apparently controlled by a combination of structures and degrees of fracturing present.

Table 11 outlines the characteristics of the Roosevelt field.

The pour point and high paraffin content present a rather difficult production problem. The unusually high content of paraffin wax carried by the crude, amounts to approximately 35 percent. Hydraulic free-type pumps have proven to be more economical than conventional pumps in conveying the crude to the surface. Insulated trucks transport the preheated oil to the Salt Lake refinery.

Red Wash Field, located in northeastern corner of the Uinta Basin, was discovered by the California Company in 1951.

The field is located upon an anticlinal nose similar to that of the Roosevelt field. Production emanates from a series of thin sandstones at a depth of 5100 to 5800 feet in the Green River formation. The sands contain good porosity and permeability which in some cases exceeds 1000 md. Production in the field is in all probability controlled by structure and adequate development of lenticular sands.

Table 12 describes a number of features dealing with Red Wash field.

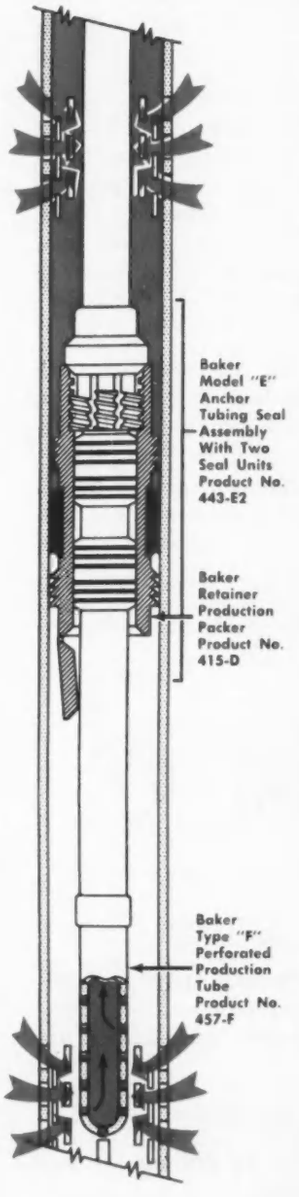
Production problems are greatly increased by a high paraffin content together with a high pour point. In the early life of the field, the crude was necessarily preheated and shipped in insulated trucks to the Salt Lake refinery. At the present time, the crude oil flows from the well through electrically heated flowlines into electrically heated storage tanks, and from the storage tanks through pumps which are equipped to automatically gage the production being pumped. into an electrically heated spur line leading to the Salt Lake pipe line. Red Wash crude is injected at intervals into the Salt Lake pipe line, where it is mixed with Rangely crude. The Salt Lake pipe line has one heating station between the Red Wash junction and Salt Lake City. This method of transportation has been successful in preventing the adverse qualities of the crude from becoming a deterring factor in its production. Suggestions and plans for dewaxing plants have been discussed.

Sandfracing in the Red Wash field has been remarkably successful. As a result of remedial work involving the

for all

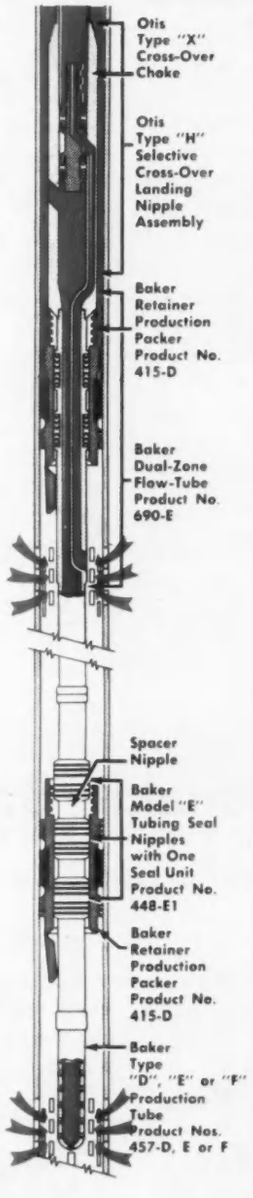
DUAL ZONE

SINGLE PACKER


Baker Model "E" Anchor Tubing Seal Assembly With Two Seal Units Product No. 443-E2
Baker Retainer Production Packer Product No. 415-D
Baker Type "F" Perforated Production Tube Product No. 457-F

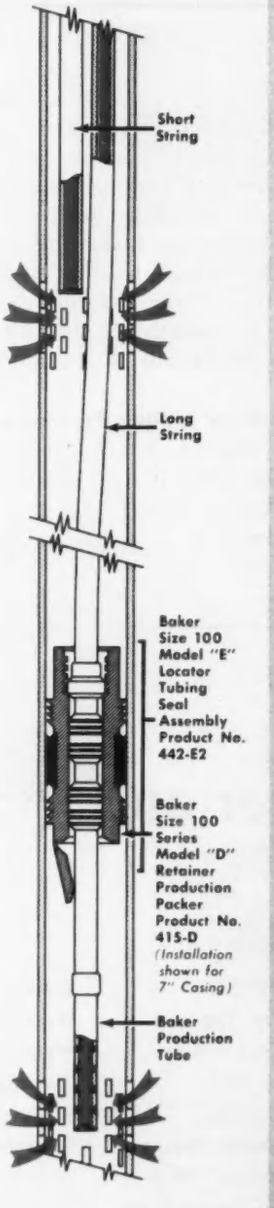
Illustrates Packer set in casing, with anchored production string for dual zone production. Tubing can be released from packer by rotating to right.

SELECTIVE CROSS-OVER


Otis Type "X" Cross-Over Choke
Otis Type "H" Selective Cross-Over Landing Nipple Assembly
Baker Retainer Production Packer Product No. 415-D
Baker Dual-Zone Flow-Tube Product No. 690-E
Spacer Nipple
Baker Model "E" Tubing Seal Nipples with One Seal Unit Product No. 448-E1
Baker Retainer Production Packer Product No. 415-D
Baker Type "D", "E" or "F" Production Tube Product Nos. 457-D, E or F

Illustrates selective two packer dual zone production hook-up (Baker-Otis) with Cross-over Choke installed. Flow pattern can be switched with Parallel Flow Choke.

PARALLEL STRING


Short String
Long String
Baker Size 100 Model "E" Locator Tubing Seal Assembly Product No. 442-E2
Baker Size 100 Series Model "D" Retainer Production Packer Product No. 415-D (Installation shown for 7" Casing)
Baker Production Tube

Illustrates simplest type of parallel string installation. Other installations involving two packers with full-opening tubing running through and below lower packer available.

SUPPLEMENTAL APPLICATIONS

WATER OR GAS INJECTION

The Baker Retainer Production Packer contains features that permit it to be used as a squeeze or testing tool as well as a temporary or permanent bridge plug. It is thus used in a variety of supplemental applications such as gas or water injection, testing, fracturing, acidizing, etc., that may be required either during the completion phase of a well or during a later phase.

FRACTURE, ACIDIZE SWAB-TEST OR SQUEEZE CEMENTING

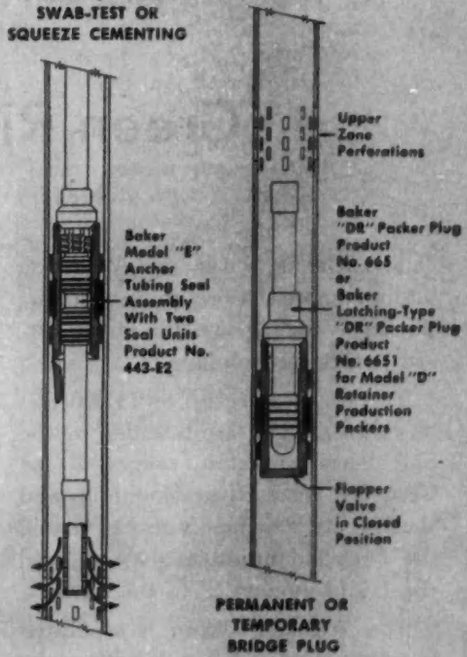

Baker Model "E" Anchor Tubing Seal Assembly With Two Seal Units Product No. 443-E2
Upper Zone Perforations
Baker "DB" Packer Plug Product No. 665 or Baker Latching-Type "DB" Packer Plug Product No. 6651 for Model "D" Retainer Production Packers
Flapper Valve in Closed Position

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TABLE 13

Pay Zones	Typical Core Analysis	Structure	Physical Prop. Oil	Initial Field Press.	Type Drive	Completion Practices
Wasatch	No cores	Fault trap	Grav.=42° API Sulfur=0.1% Pourpoint=100° F. Paraffin Base	5350 psi	Gas Solution	E.S., micro and radic- activity log. Csg. set top of pay zone.

TABLE 14

Pay Zones	Typical Core Analysis	Structure	Physical Prop. Oil	Initial Field Press.	Type Drive	Completion Practices
Weber Sandstone	Por.=13.2% Perm.=84 md	Anticline	Grav.=31.5° API Paraffin Base	2120 psi	Water	Run E.S. Log, Set pipe on top Weber.

sandfrac operation, a number of wells have shown production increases of 300 to 400 percent.

Duchesne Field, located in the northwestern portion of the Uinta Basin in Duchesne County, Utah, was discovered by The Carter Oil Company and Continental Oil Company in 1951. The field is located on a fault trap and produces from a fractured sandstone in the Wasatch formation at approximately 7500 feet in depth.

Table 13 illustrates a number of the characteristics of the Duchesne field.

A high paraffin content together with a high pour point has created a difficult production problem. Free-type hydraulic pumps have been found to be the most economical and effective method of bringing crude of this nature to the surface. At the present time, the preheated crude oil is transported to the Salt Lake refinery by means of insulated trucks.

Ashley Valley Field is located upon a faulted anticline situated on the Blue Mountain Uplift in Uintah, County, Utah.

Gas in commercial quantities was discovered in 1925 in the Morrison and Entrada formations. During 1948, a deep test encountered commercial quantities of oil in the Weber formation thus inaugurating Utah's first oil field. Production in the field is primarily from the Weber sandstone although the lower section of the Phosphoria formation also is a source of production.

Table 14 is a brief summary of features concerning the Ashley Valley field.

Due to the presence of a very active water drive, all wells in this field have been flowing since completion. Water production in some parts of the field are quite excessive, ranging between 60 to 70 percent in some cases. Since the produced water is fresh, the problem of disposal is minor.

The nature of the produced crude creates a secondary problem consisting of paraffin deposition in the tubing of the flowing wells. This problem has been satisfactorily solved by the use of paraffin cutters run on a wire line once or twice a month.

Green River and Washakie Basins

THE GREEN RIVER and Washakie basins comprise the southwestern portion of Wyoming and the northwestern portion of Colorado.

The basins have up to 15,000 feet of sediments and are bounded by the Salt River mountain ranges to the west, the Wind River mountains and the Sweetwater Uplift to the north, the Park mountains to the east, and the Uinta mountains to the south.

The Washakie Basin is separated from the Green River Basin by the Rock Springs Uplift.

Production—The main production in the basins is gas and condensate. The productive horizons are summarized in Table 15.

Fields

Big Piney	Wyoming
Tip Top	Wyoming
No. La Barge	Wyoming
La Barge	Wyoming
Pinedale	Wyoming
Church Buttes	Wyoming
Spring Valley	Wyoming
No. Baxter Basin	Wyoming
So. Baxter Basin	Wyoming
Middle Baxter Basin	Wyoming
Table Rock	Wyoming
Salt Wells	Wyoming
East Hiawatha	Wyoming & Colorado
West Hiawatha	Wyoming & Colorado
Clay Basin	Wyoming
South Baggs	Wyoming
Sugar Loaf	Colorado
Canyon Creek	Wyoming
Powder Wash	Colorado

Reservoir Characteristics

Types—Anticlinal traps;—Anticline with sand pinch-outs (lenses). Rock—Sandstones—consolidated and lenticular.

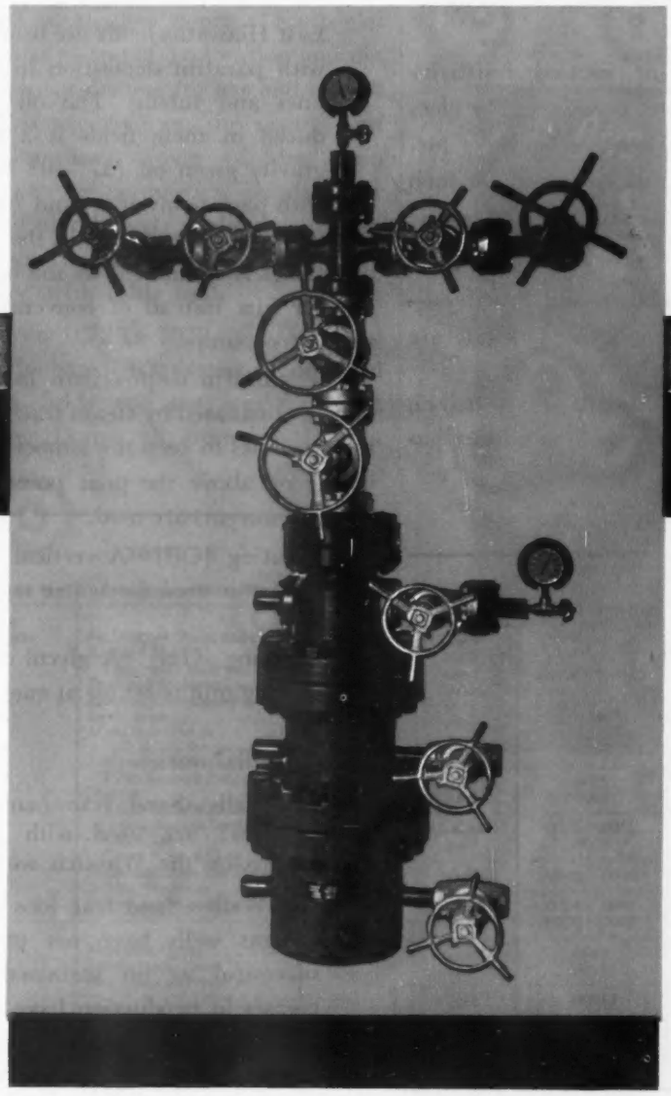
Drilling Operations

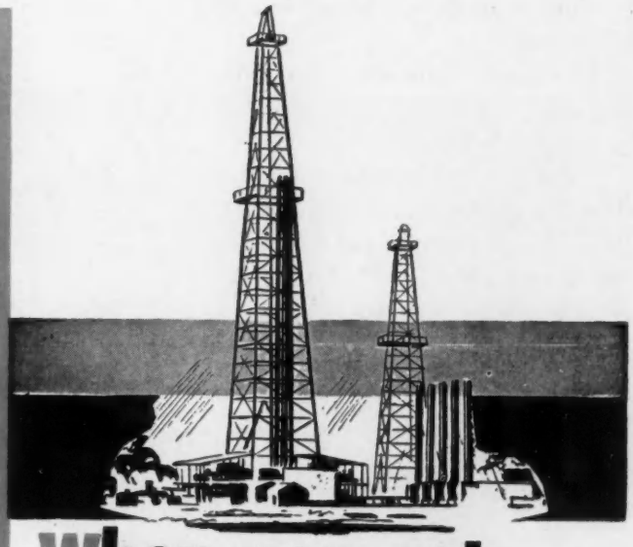
Two methods of drilling are used in the basins.

1. Conventional rotary drilling with oil emulsion mud.
2. Gas drilling.

Mud logging units are used and a gas analyzer is used on all development wells. Any shows of gas in the drilling mud, or any drilling breaks encountered are tested on the way down.

Completion Practices—When gas





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drilling is used for completion, the procedure is:

Production string set on top of pay.

Pay is drilled into with gas.

Liner is normally run to TD.

When gas is not used for completion, the production string is normally set through the pay and the casing perforated after being swabbed dry.

Logging Procedure—Two types of logs are run:

1. Conventional E.S. and Microlog before production string is set.
2. Gamma Ray—Neutron Log with collar locator prior to perforating.

No special or focused resistivity logs are deemed necessary. No electric log calculations are made for formation content as the results of such calculations are not believed to be reliable.

Production Problems and Practices—

1. Sand—no problem as sands are consolidated.
2. Corrosion—mild at Church Buttes field which produces gas and condensate.
3. Paraffin—Powder Wash and East Hiawatha fields are troubled with paraffin deposition in flow lines and tubing. The oil produced in these fields is a high gravity green oil (37°-40° API) with pour point of around 70° F.

The paraffin deposition in the tubing strings is eliminated by the use of plunger lifts instead of conventional sucker rod pumps.

The paraffin deposition in flow lines is eliminated by steam tracing of the flow lines to keep the temperature of the oil above the pour point. No paraffin solvents are used.

4. Treating (Oil)—A vertical type treater is used for water separation.
5. Treating (Gas)—A glycol dehydrating unit is set up at each gas well.
6. Remedial work—

Oil Wells—Sand frac (sand-oil squeezes) are used with good success on the Wasatch wells.

Gas Wells—Sand frac jobs done on gas wells have not proven successful as no sustained increases in production have been realized.

Secondary Recovery—None.

TABLE 15

FIELD	Formation	Approx. Depth	Production
North Baxter Basin	Frontier—sand	2450	Gas
	Dakota—sand	3050	Gas
	Basal Morrison—sand	3500	Gas
	Nugget—sand	4000	Gas
Middle Baxter Basin	Frontier—sand	1900	Gas
	Dakota—sand	2470	Gas
	Lakota—sand	2675	Gas
South Baxter Basin	Frontier—sand	2200	Gas
	Dakota—sand	2800	Gas
East Hiawatha	Wasatch—sand	2200—3500	Gas & Oil
	Fort Union—sand	4500	Gas
West Hiawatha	Wasatch—sand	2100—2300	Gas
Powder Wash	Wasatch—sand	2800—5000	Gas & Oil
	Fort Union—sand	5000—6200	Gas
Clay Basin	Frontier—sand	5400	Gas
	Dakota—sand	5700	Gas
Church Buttes	Dakota—sand	13000	Gas
Sugar Loaf	Mesaverde—sand	5000	Gas
Canyon Creek	Mesaverde—sand	5600	Gas

Four Corners Area

THE SAN JUAN BASIN is one of the major basins of the Colorado plateau in the Four Corners region of Colorado, New Mexico, Arizona, and Utah. It is a large relatively pronounced extra mountain basin which is formed by the Hogback flex, which is a part of the Defiance uplift to the west. This flex continues to the northwest and bends around the north side including the San Juan Dome and extends southeastward into the Nacimiento uplift on the east. The boundary of the basin along the south is formed by the Lucero and Zuni uplifts. Considerable volcanic activity of recent geologic age, has occurred in these uplifts surrounding the basin.

The ancient uplifts have been positive from Pre-Cambrian until late in the geologic time. This has resulted in a good representative deposition of nearly all the formations of the various geologic periods. The dip of beds in the basin are gentle on the south and southeast with steeper dips on the north and northeast to east sides. The center of basin or the deepest portion lies just south of the Colorado-New Mexico border with a northwest-southeast trend.

Table 16 is a geologic section of the principal formations and subdivisions present in nearly all of the basin.

History of Development. Due to the isolation and sparsely settled regions, early exploration of the basin for oil or gas was not carried out until 1920. A commercial gas field was found in the Dakota formation in 1921. This was on the northwest

rim of the basin and the Dakota was found at shallow depth. This began the first period of exploration and development drilling for gas and oil. All of this occurred on the north, west and southern edges of the basin where the producing sands were found at relatively shallow depths on surface anticlines. The wells were drilled with cable tools.

From 1922 to 1929, oil was found in Hogback, Rattlesnake and Red Mesa fields and gas was found at Barker Dome, all from the Dakota

TABLE 16

Geologic Age	Formation or Subdivision	Producing
Tertiary Cretaceous	McDermott Shales and Sands	
	Kirtland Shale	
	Farmington sand lens	Oil
	Fruitland Shales and sands	Gas
	Pictured Cliffs Sandstone	Gas
	Lewis Shale	
	Mesaverde Group	
	Cliff House Sandstone	Gas
	Menefee Shale and Sands	Oil
	Point Lookout Sandstone	Gas
	Mancos	
	Upper Mancos Shale	Oil
	Gallup-Hospah Sandstone	Oil
	Tocito Lens	Oil
	Lower Mancos Shale	
	Greenhorn Lime and Shale	Oil
	Dakota Sandstone	Oil & Gas
	Burro Canyon conglomerate	
Juriassic	Morrosion Group	
	San Raphael Group	
	Glen Canyon Group	
Triassic	Chinle	
	Shinarump Conglomerate	
	Moenkopi formation	
	Unconformity	
Permian	Cutler	
Pennsylvanian	Rico Transition	
	Hermosa	
	Upper Limestone and Shales	
	Paradox Shale and thin Sands or Lime	Oil & Gas
	Lower Limestone	
	Molas	
Mississippian	Leadville Limestone	Oil & Gas
Devonian	Ouray Limestone	Gas
	Elbert Shales	
Cambrian	Ignacio Quartzite	

formation. In addition oil was found at Hospah, Red Mountain and Stoney Buttes in the Menefee sands, also at shallow depths, and two gas wells were completed in the Pictured Cliffs sand and Cliff House sand. Dark oil production from each of these fields was not very high and development drilling was slow. This was brought about by lack of transportation and the extremely limited market.

Two additional fields, Table Mesa

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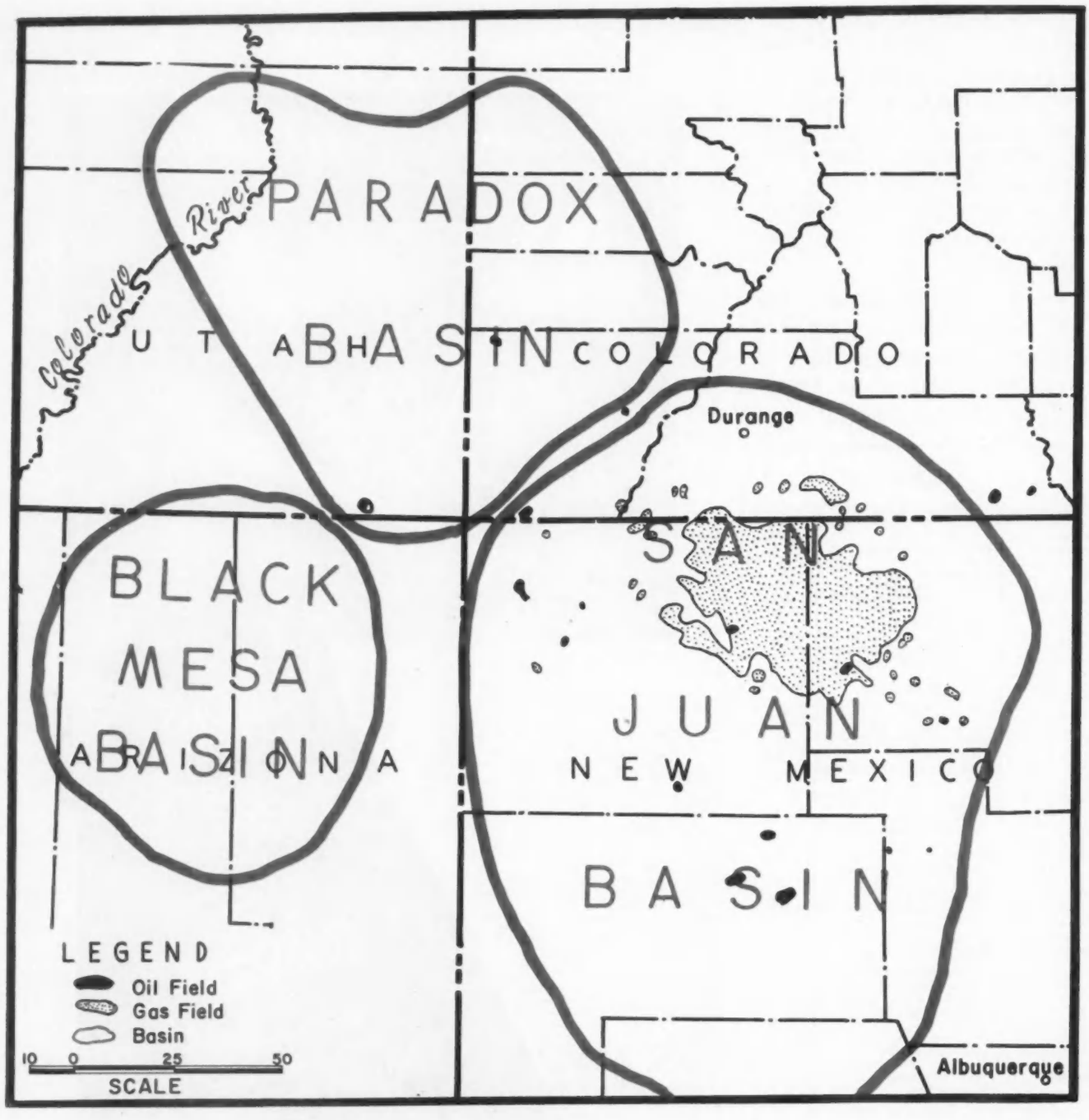

in New Mexico and one in Colorado were discovered in 1935. Again production was found at shallow depths in the Dakota formation on recognized surface structures.

In 1929 a deep test was drilled at Rattlesnake that found production in the Paradox member of the Hermosa formation. The initial production was 650 barrels of oil and 1300 barrels of water. The oil was 42 gravity paraffin base crude containing some sweet solution gas. Four additional deep tests were drilled during the period 1932 to 1940 and found some additional production in the Paradox, and Helium bearing gas was found in the Leadville and Ouray formation.

The production found in the pre-Pennsylvanian formation at Rattlesnake field created interest in deeper tests throughout the basin. The Paradox and Leadsville pay zones are stratigraphic in that production was found in porous limes or dolomites which was also a deterent to much exploratory drilling. Outside of scattered wildcats very little exploration took place from 1929 through 1944.

In March, 1945, Pennsylvanian gas production was discovered at Barker Dome field in San Juan County, New Mexico. This well was complete in the porous limestone members of the Paradox of the Hermosa formation for 42 million cubic feet of gas per

day with original formation pressure of 2975 psi.

This well centered attention on gas wells and exploration activities began to increase. There had been some development drilling in the Fulcher-Kutz Canyon field near the town of Aztec, New Mexico and wildcats in this area found additional gas production from the Pictured Cliffs sand. Two wells in this area found gas production and indications of substantial gas reserves in the Farmington, Pictured Cliffs, Mesa Verde and Dakota formations in the central portion of the basin.

From 1946 through 1949 development drilling and exploration activities increased steadily and sufficient gas reserves were indicated. Based on this, El Paso Natural Gas investigated this area in 1950 and was granted the right to construct a pipe line from the area to the California markets. Development heretofore stymied by lack of a market was stepped up and exploration by numerous companies commenced. By 1955, Fulcher-Kutz canyon field had developed and merged with the West Kutz pool, South Blanco, and Lindreth areas until this area is called the Blanco Mesa Verde pool. Gas production is found in various sands of the upper cretaceous series from the youngest Fruitland through Pictured Cliffs, Cliff House, Point Lookout and Dakota sands. This area lies in San Juan and Rio Arriba counties with a generally northwest-southeast trend. With one outlet, and the second one, Pacific Northwest pipe line, under construction. The exploration and development has been increased during 1954 and 1955.

Well Completion. The early drilling was done with cable tools for several reasons: shallow depth, compact shales and sands, poor roads and isolated locations, lack of water, and adaptability of these tools to the drilling conditions with low costs. Drilling and completion of the wells was simple. Surface or upper water sands were cased off and when the known or expected producing sand was reached the six or seven inch production string was set on top and cemented. The sand was then drilled with a smaller hole usually partially penetrating in the case of an oil producer or full penetration if gas productive. The Dakota sand when oil productive usually has water at the base.

Since 1941 most of the wells have been drilled and completed with rotary tools. Although the rotary drilled hole can be drilled faster two factors enter the picture which has caused radical changes in rotary drilling in this area. One is lost circulation troubles, notably in the Meneffee shales between the Cliff House and Point Lookout gas sands. The second is the gas sands contain varying amounts of shale that mud filtrate will cause to swell, thus severely damaging the gas sand. Earlier rotary practices were to drill to the top of the gas sand, set the production string and drill the sand with a low water loss mud, or cable tools.

To offset the mud filtrate damage, the wells were shot with solidified nitroglycerine, as much as 2400 quarts for the 600-800 feet productive section. Some of the sands have sufficient pressure and productivity to clean out the wells, however in many cases the clean out work after shot was excessive and costly. El Paso Natural Gas Company developed the method of drilling the producing sand with natural gas. The well is drilled to near the top of the producing gas sand and the production string is set.

The sand is then drilled with regular rotary tools using natural gas as the circulating medium. This has eliminated lost circulation troubles with resultant blowouts and/or mud filtrate damage to the pay sands. This completion method is used in nearly all of the gas wells at present and the completions have been much better than previous. Some of the wells are still shot with solidified nitroglycerine to increase productivity, but individual sand conditions dictate whether to shoot.

A more common practice during the last year to increase the productivity is sand oil fracturing of the separate gas zones or formations as they are drilled. The zone is drilled with gas and fractured with 10,000 to 15,000 gallons of oil using one to one and one-half pounds of sand per gallon of oil. This zone is then opened up and blown dry, before drilling to the next zone, setting a cement retainer in a hard sand, and repeating the process. Excellent increases of 100 to 1000 percent have been realized with this method. A more recent practice is to use gelling agents with water, since it eliminates purchase and trucking the oil to the location. Good results have been realized with this although some controversy has arisen over possible water damage to the producing zone from the swelling of the clay material contained in the sand. Using plain water the size of the fracturing job has been increased and also the entire zone is drilled, then the production string is set through and cemented. After perforating the individual zones they are fractured with sand and water. An average treatment down the casing is 40,000 gallons of water and 1½ pounds of 20-40 mesh sand per gallon or 60,000 pounds.

Logging Methods. Until the advent of gas drilling of the gas sands conventional electric logs were usually run in the rotary drilled holes. In those wells where cable tools were used to drill the gas sands the radioactivity logs have been run. Where the drilling is done with gas only the radioactivity logs are run, although the induction log has been used also.

No particular logging problems are evident and both types of logs have been widely used for correlation work and subsurface geology work. The logs have aided and provided the clues for developing the gas sand since they are stratigraphic traps with sand developments in the shales.

Producing Horizons. The Cretaceous sands that are productive of oil or gas are usually shore-line deposits from the seas that entered the basin during this geologic period. As a result they are highly gradational and the shale content varies greatly: To a great extent this type of deposit is stratigraphic or lenticular and nearly all of the gas sand reservoirs are considered to be this form. The Dakota sand is

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somewhat of an exception as the formation thickness is uniform, but thin shale streaks and clay content break the formation into sand lenses and permeability barriers so that stratigraphic traps are present.

The productive intervals in the Paradox member of the Hermosa formation, Pennsylvanian Age, are also stratigraphic. This is a result of limestone development in the facies change and in turn porosity development within the limestone is either primary or secondary solution cavities or channels. A good example of this type of development is the Paradox reservoir at Barker Dome.

This depositional lithologic change with the sand reservoir has a direct bearing on the porosity and permeability. Porosity values for the Upper Cretaceous gas sands average 10 percent with permeabilities of a low order usually 1 to 2 millidarcys. Within the Dakota sand the porosity is somewhat higher, 12-14 percent with permeabilities of 5-20 millidarcys.

Reservoir pressures vary greatly with producing formations and depth and are somewhat unpredictable. The pressures found in the gas sands are below the normal hydraulic gradient and appear to be dependent on sand development. In some areas of the Blanco field slightly higher pressures have been noted in the better sand development areas.

In those reservoirs where oil production is found, particularly the Dakota, pressure maintenance from a water drive is the usual case. The Hogback field is a prime example of a water drive reservoir. Water production has been encountered in all of the Paradox reservoirs and pressure maintenance is good.

The productivity of the oil wells has varied from an average initial production of 50 bopd to as high as 1372 bopd flowing.

The natural initial production of the Cretaceous gas sand wells varied between 500 Mcf to 30,000 Mcf per delivery pressure to the gas pipe line. These capacities have reduced considerably.

An oddity in these gas sands is the

high productivity versus the low porosity and permeability. Numerous temperature surveys and spinner surveys have given definite indication that the majority of the gas is produced from the sand-shale interphase. Close correlation with gama-ray log have confirmed this conclusion.

Crude Oil. The crude oil produced in the basin is a sweet paraffin base crude of good quality and high gravity. Table 17 shows the field, horizon and gravity for some of the crudes.

Gas. The gas produced from the upper Cretaceous sands probably has as its origin the numerous coal beds occurring within these same formations and as a result is extremely high in methane content usually 83 to 87 percent. Some distillate is produced with this gas, 0.6 to 1.5 gallons per 1000 cubic feet, and in some instances richer.

The gas produced from the Paradox at Baker Dome contains 14 percent sulfur and is treated for recovery of the sulfur.

All of the gas that is sold is taken by El Paso Natural Gas Company. Many of the wells and some of the newer fields are waiting on completions of Pacific Northwest pipe line for a market.

TABLE 17

FIELD	Producing Horizon	Gravity Degrees API
Rattlesnake	Dakota	72°
	Hermosa	42°
Hogback	Dakota	60°
Table Mesa	Dakota	56°
	Leadville Ouray	52°
Hospah	Hospah-Gallup	29°
Doswell	Tocito Lentil	50°
Chromo	Mancos-Greenhorn	32°
Angels' Peak	Dakota	34°
Stoney Butte	Dakota	48°

Most of this crude oil has been marketed locally.

Laramie Basin

ALBANY AND CARBON COUNTIES, WYOMING, AND LARIMER COUNTY, COLORADO

Bounded by:

North—Strong sedimentary east-west folds which are part of the Seminole-Freezeout Hills.

South—Juncture of the Medicine Bow and Laramie Ranges with the Front Range of Colorado.

East—Laramie Range.

West—Medicine Bow Range.

Main production is from reservoirs of Cretaceous, Jurassic, and Pennsylvanian age. Generally sweet oil. The fields are small, except Rock Creek, Medicine Bow, and Quealy Dome, and production has been hampered by water production.

Fields in Laramie Basin:

Big Hollow
Rex Lake
Little Laramie
Herrick
Seven Mile
Dutton Creek
Horne Brothers
Rock Creek (or Rock River)
Big Medicine Bow
Little Medicine Bow
Oil Springs
Allen Lake
East Allen Lake
Quealy Dome

BIG HOLLOW FIELD ALBANY COUNTY, WYOMING

Discovered—1038 19° API Oil

Remarks—This field produced from the Muddy, approximate depth 800 feet, but was abandoned in 1952 after production of 19,000 barrels of oil.

The Dakota was found at 2550 feet. The only record of remedial work that was found indicated that cleanouts and squeezing with mud acid were the extent of the remedial work.

The Tensleep formation in this field tested water.

REX LAKE FIELD ALBANY COUNTY, WYOMING

Formation	Approx. Depth	Production	I. P.
Shannon	425′	Gas	200 MCF/D
Muddy	3800	Oil—34°	60 bopd
Dakota	3900 to 4000	Oil—31°—mixed	
Lakota	Separated from the Dakota by a 2′ shale break	Dakota and Lakota	400 bopd

Discovered—1923

Structure—A small elongated dome on the eastern slope of the Medicine Bow Mountain Range.

Tested Sundance and Tensleep with no results.

Driving Mechanism

Shannon—gas
Muddy
Dakota and Lakota—water drive.

Corrosion Problems—None.

Treating Problems—None. Use gun barrels for the produced fluid.

Paraffin Problems—None.

Completion Practices—Early completion practices not known. Records of this field are very sketchy.

Remarks—Present production is approximately 80 bopd. One small gas well is used to supply fuel for field use.

Productive Area—300 acres.

Cumulative Production—592,006, 1-1-1955.

LITTLE LARAMIE FIELD ALBANY COUNTY, WYOMING

Formation	Approx. Depth	Production	I. P.
Casper (Tensleep)	3600	Oil—23°—Sour—3% S	326 bopd

Discovered—1948

Structure—A highly asymmetrical fold trending north-south with steep dips and thrust faulting occurring on the east.

Driving Mechanism
Casper—Water Drive

Corrosion Problems—Slight corrosion but to date has not presented any problems.

Treating Problems—None. Use treaters with small amounts of chemical and approximately 140° on treater.

Paraffin Problems—None.

Remedial Work—None to date. A sandoil squeeze has been proposed and will be tried in the near future.

Completion Practice—Casing set through

the formation and perforated. Have electric logs on all wells.

Remarks—The Muddy formation had shows but failed to recover commercial quantities of oil or gas on DST.

Productive Area—100 acres.

Present production is from 5 Casper wells. The cumulative production to 1-1-1954 was 346,866 barrels.

HERRICK FIELD
ALBANY COUNTY, WYOMING

Formation	Approx. Depth	Production	I. P.
Casper (Tensleep)	3638	Oil—25°—sour crude 3% S	265 bopd

Discovered—1947

Structure—A small dome located on an anticlinal fold.

Driving Mechanism
Casper—Water Drive.
Porosity 20%, Permeability 800 md.

Corrosion Problems—None to date.

Treating Problems—None. Use treaters with chemical. Approximately 140° on treater.

Paraffin Problems—None.

Remedial Work—Sandoil squeeze pending and will be done soon. Previous remedial work consisted of cleanouts and routine well servicing.

Completion Practices—Casing set through sand and perforated.

Remarks—Five wells drilled (4 producers and 1 dry hole).

Productive area—100 acres.

Presently producing large amounts of water.

Cumulative Production 1-1-1954, 400,312.

SEVEN MILE FIELD
ALBANY COUNTY, WYOMING

Formation	Approx. Depth	Production	I. P.
Muddy 1 well	5800	Oil—33°	Not Known—Water Drive
Lakota 1 well		Oil—31°	Not Known—Water Drive

Discovered—1947

Corrosion Problems—None.

Treating Problems—None. Use treaters and small amounts of chemical.
Paraffin Problems—Paraffin scrapers in both wells.

Completion Practices—Casing set through and perforated.

Remedial Work—The Muddy sand well was squeezed with mud acid and kerosine with fair results.

Secondary Recovery Application—None.

Remarks—More develoment possible, this is a debatable point due to the faulting of the reservoir. A well recently drilled in this field was plugged when it was determined that the producing formations were faulted out.

Present production is 80 bopd and 100 bwpd.

Cumulative production 1-1-1954, 46,534.

DUTTON CREEK
CARBON COUNTY, WYOMING

Formation	Approx. Depth	Production	I. P.
Shannon	1600	Gas-depleted 1952	330 to 1000 Mcf/d
Muddy	4900	Oil—34°—green	90 bopd
Sundance	5350	Water	

Discovered—1926

Structure—A high on the Rock Creek Anticline with a north-south trend. Dakota, Lakota, Morrison, Sundance, and Jelm formations were tested and found to contain water.

Driving Mechanism
Shannon—gas
Muddy—sol. gas, limited water drive.

Corrosion Problems—None.

Treating Problems—None.

Paraffin Problems—None.

Completion Practices—Set casing into top of formation and produce from the open hole. Early wells had drillers logs only while some of the late wells had electric logs.

Secondary Recovery Application—None.

Remarks—Field now shut in.

Cumulative Production 1-1-1954, 416,524. Three wells produced 4852 barrels of oil from the Muddy sand in 1953.

HORNE BROTHERS UNIT
CARBON COUNTY, WYOMING

Formation	Approx. Depth	Production	I. P.
Morrison	6200	Oil—36°	Flowed 124 bopd on ¼" choke

Discovered—1951

Structure—Located on an axial extension of the Foote Creek Anticline.
Muddy sand poorly developed. Tensleep was dry.

Driving Mechanism
Morrison—sol. gas drive.

Corrosion Problems—None.

Treating Problems—None.

Paraffin Problems—None.

Completion Practices—Casing set through and perforated. Electric logs run.

Remedial Work—None.

Secondary Recovery Application—Not known.

Cumulative Production 1-1-1955, 92,515.

ROCK CREEK (ROCK RIVER)
CARBON COUNTY, WYOMING

Formation	Approx. Depth	Production	I. P.
Wall Creek	1750	Oil—1 well	40 bopd
Muddy	2500	Oil	50 bopd
Dakota	2600	Oil—34°—	
Lakota	2650	brownish green	
Sundance (1935)	3000	Oil	
Casper	5400	Oil—36°—greenish black Water	20 bopd

Discovered—1918

Structure—An asymmetrical anticline on the east slope of the Medicine Bow range.

Corrosion Problems—None.

Paraffin Problems—Scraper Rods used.

Treating Problems—None. Gun barrels used with chemical added in colder weather.

Completion Practices—Both open hole and cased completions. The early wells had drillers logs only. Later wells have electric logs.

Remedial Work—Not known.

Remarks—In 1921 a gasoline plant was put into operation with a capacity of 3 MMCF/D. By 1937 when it was shut down it had processed about 10¼ billion CF of gas. Gasoline recovered ranged from 1 to 3 GPM. The plant was reopened in 1938 to repressure the Dakota reservoir. Prior to this a small amount of gas had been recycled into

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the Dakota during the years from 1929 to 1936. Present injection rate is approximately 500 MCF/D through 5 injection wells.

Productive area—Dakota 1400 acres; Sundance 160 acres.

Present production is from 28 wells. Cumulative production as of 1-1-1955 was 30,312,188.

MEDICINE BOW FIELD
CARBON COUNTY, WYOMING

Formation	Approx. Depth	Production	I. P.
Wall Creek	4000	Oil—soon depleted	200 bopd
1st Sundance	5200	Wet gas	81,000 Mcf/d
Basal Sundance	5400	Oil—63°—	6,300 bopd
Tensleep	6800	Oil—62°-sweet	1,920 bopd

Discovered—1923

Structure—Pronounced asymmetrical fold entirely surrounded by escarpments of Mesa Verde formation.

Driving Mechanism
1st Sundance—Gas.
Basal Sundance—Sol. gas drive.
Tensleep—Water drive.

Corrosion Problems—None.

Treating Problems—None. Use both treaters and gunbarrels. Approximately 130° temperature on treaters. Small amounts of chemical used in colder weather.

Paraffin Problems—None.

Remedial Work—Sandfracs using the high gravity lease crude. Gelling agent used on some jobs. Good results.

Completion Practices—Casing set on top the formation in some wells and set through and perforated in others. The early wells had only drillers logs but the later wells have electric logs and some radioactive logs.

Productive Area—1st Sundance, 1200 acres; Basal Sundance, 150 acres; Tensleep, 150 acres.

Present Producing Wells—Sundance, 4; Tensleep, 2.

Cumulative Production 1-1-1955, 5,965,-037 barrels.

Remarks—Since 1937 all excess gas, propane, and butane from this field have been piped to Rock Creek and injected into the Dakota formation.

Secondary Recovery Application—None.

LITTLE MEDICINE BOW FIELD
CARBON COUNTY, WYOMING

Formation	Approx. Depth	Production	I. P.
Sundance	6900	Oil 37° Pour point 65° Intermediate base crude GOR 100/1	275 bopd

Discovered—1953

Structure—located on the Medicine Bow Anticline.

Driving Mechanism—Water Drive.

Corrosion Problems—None.

Paraffin Problems—None. Some deposition initially but none at present. Initial deposition was asphaltine in nature.

Treating Problems—None. Treaters used with heat approximately 140°. No chemical used at present.

Completion Practice—Casing set into top of sand in some wells set through and perforated in others. Electric logs on all wells.

Remedial Work—None to date.

Secondary Recovery Application—None.

Present Production—330 bopd and 80 bwpd.

OIL SPRINGS

Discovered—1938

Formation	Approx. Depth	Production
Dakota	1600	Gas
Sundance	2350	Gas

Corrosion Problems—Not known.

Treating Problems—Not known.

Paraffin Problems—Not known.

Completion Practices—Casing set into top of Sundance formation.

Remedial Work—Not known.

Remarks—The field is now used for gas storage by the Northen Utilities Co.

Productive acreage—140.

ALLEN LAKE FIELD
CARBON COUNTY, WYOMING

Formation	Approx. Depth	Production	I. P.
Muddy	1350	Gas	35 Mmcf/d
Cloverly	1400	Gas show	None
Morrison	1550	Gas show	None
Sundance (1932)	1700	Gas	75 Mmcf/d
Tensleep	3500	None	(3 wells) None

Discovered—1918

Structure—A small dome at the northern end of the Allen Lake Anticline.

Driving Mechanism—Muddy and Sundance—gas.

Corrosion Problems—Not known.

Treating Problems—Not known.

Paraffin Problems—Not known.

Completion Practices—Not known.

Remedial Work—Not known.

Remarks—Originally the gas from this field was sold to the town of Laramie. In 1933 the gas was piped to Medicine Bow for sale there. The field was shut in in 1944 because the gas could not be produced at sufficient pressure for sales. A compressor was installed and the wells again produced. The field was depleted and is now abandoned.

EAST ALLEN LAKE FIELD
CARBON COUNTY, WYOMING

Formation	Approx. Depth	Production	I. P.
Wall Creek	600	Water	15 Mmcf/d
Sundance	2400	Gas—depleted in late 1940's	
Tensleep (1948)	4000	Oil—22°	150 bopd

Discovered—1936

Structure—A small dome at the southeast end of the Allen Lake Anticline.

Driving Mechanism
Sundance—Gas.
Tensleep—Water Drive.

Corrosion Problems—None.

Treating Problems—None.

Paraffin Problems—None.

Completion Practices—Casing set through the formation on some wells and set into the top of the formation on other wells. Most of the wells have electric logs.

Remarks—Sundance formation was depleted in the late 1940's, now shut-in. Cumulative Production, 1-1-1955, 147,037.

In 1953 one Tensleep well was being produced. Production for that year was 22,533 barrels.

QUEALY DOME
ALBANY COUNTY, WYOMING

Formation	Approx. Depth	Production	I. P.
Muddy (1934)	3150	Oil—34°—sweet	50 bopd
Dakota (1936)	3230	Oil—35°—sweet	450 bopd
Lakota (1936)	3280	Oil—35°—sweet	
Sundance (1939)	3660	Oil—34°—sweet	15 bopd (1 well)
Casper (1947)	4800	Oil—23°—sour 3% S	80 to 480 bopd

Discovered—1934

Structure—A small sharply folded elongated dome covered entirely by alluvium and terrace gravels except for scattered outcrops of the Steele shale.

Driving Mechanism—All reservoirs in this field are produced by water drive.

Corrosion Problems—None.

Treating Problems—None. Produce large amounts of water. Treaters are used with chemical. A reserve emulsion is present but does not present a treating problem.

Completion Practice—Open hole completions.

Remedial Work—Sandfracs have been used to stimulate production. Lease crude (Tensleep) was used as the carrying medium. No production figures were quoted but it was stated that an increase resulted from the work. Plugbacks and DOC squeezes for water shutoff have been tried but to date have not proved very successful. Cleanouts in conjunction with mud acid squeezes have been tried with fair results. On some jobs the mud acid was preceded with kerosine.

Secondary Recovery Application—At present the California Company is injecting water into the Casper formation. As of 9-31-55 they had injected approximately 12,000 barrels of water into the formation with no results. There is the opinion among some personnel of the company that they are injecting into a separate reservoir. Injection pressures are about 3300 psi. The injection water from the treaters is treated before it is put through the Triplex. Previously the water "gummed up" the valves of the Triplex:

Remarks—There were dry holes drilled in this area in 1921, 1927 and 1931 before production was discovered in 1934. This dome was the first productive structure defined by seismograph in the Rocky Mountain area.

A sandoil squeeze has been recommended for a Muddy sand well that twice previously had been acidized with no results.

This field is completely developed. Present production is from 5 Muddy, 9 Dakota, 1 Sundance, and 8 Casper wells. Present production is 1000 bopd and 2500 bwpd.

Cumulative Production, 1-1-1954, 5,289,841.

Hanna Basin

HANNA BASIN
CARBON COUNTY, WYOMING

Bounded by:

North—Sweetwater Uplift.

South—Structural complex of sedimentary rocks on the north flank of the Sierra Madre Uplift.

East—Simpson Ridge.

West—Rawlins Uplift.

Fields in the Hanna Basin:
Overland
Hatfield
Simpson Ridge

Development to date has been expensive due to the difficult drilling operations.

HATFIELD FIELD
CARBON COUNTY, WYOMING

Formation	Approx. Depth	Production	I. P.
Dakota	3900	Gas only	21 Mmcf/d
Sundance	4200	Oil—40°	
Tensleep	6000	Oil—43°—sweet paraffin base	300 bopd

Discovered—1923

Structure—A small structural high on the end of the Miller Hill-Lake Valley Anticline.

Frontier (2900) and Muddy (3800) tested with no results. The Madison (6400) showed dead black solids in fracture planes.

Driving Mechanism—
Dakota—Gas
Sundance—
Tensleep—Water drive—fracture type reservoir with low porosity.

Corrosion Problems—None.

Treating Problems—None. Use treaters and small amounts of chemical. Approximately 140° on treaters.

Paraffin Problems—None from Tensleep but used scraper rods when producing from the Sundance.

Completion Practices—Casing set on top of sand and the open hole section shot with SNG. Early wells had drillers logs only but the later wells have electric logs.

Remedial Work—Unsuccessful attempts to shut off water which appeared in the Tensleep shortly after inception. Two wells were acidized and showed a small increase (20 bopd) for a month and then returned to previous producing rates. No sandoil squeezes have been tried.

Secondary Recovery Application—None. The large amounts of water being produced preclude the possibility of secondary recovery operations.

Remarks—One well produced gas from the Frontier but went quickly to water. Proven Area—320 acres. Two Tensleep wells were converted to Reda installations. One is still producing. Water cut on this well is 99%.

Cumulative Production 1-1-1955, 908,178.

SIMPSON RIDGE
(SADDLEBACK HILLS)
CARBON COUNTY, WYOMING

Formation	Approx. Depth	Production	I. P.
Quealy	650 (first well)	23°—brown oil	25 bopd
Quealy	3700 to 4000	None	
Shannon	2600 to 2900	None	

Discovered—1923

Structure—Narrow, elongated NE-SW trending fold, steeply dipping flanks.

Corrosion Problems—None.

Treating Problems Not known.

Paraffin Problems—Not known.

Completion Practices—Casing was set into the top of the sand. It is not know if cement was used. Early wells had drillers logs only. The two deep wells had electric logs.

Remedial Work—Thirteen wells were drilled to the shallow Quealy sand. These wells produced to 1931 when they mudded in. In 1936 and 1937 some of the wells were cleaned out and returned to a producing status. Also in 1937 two wells were drilled to the Steele shale (5600 and 4500) but proved dry and were abandoned.

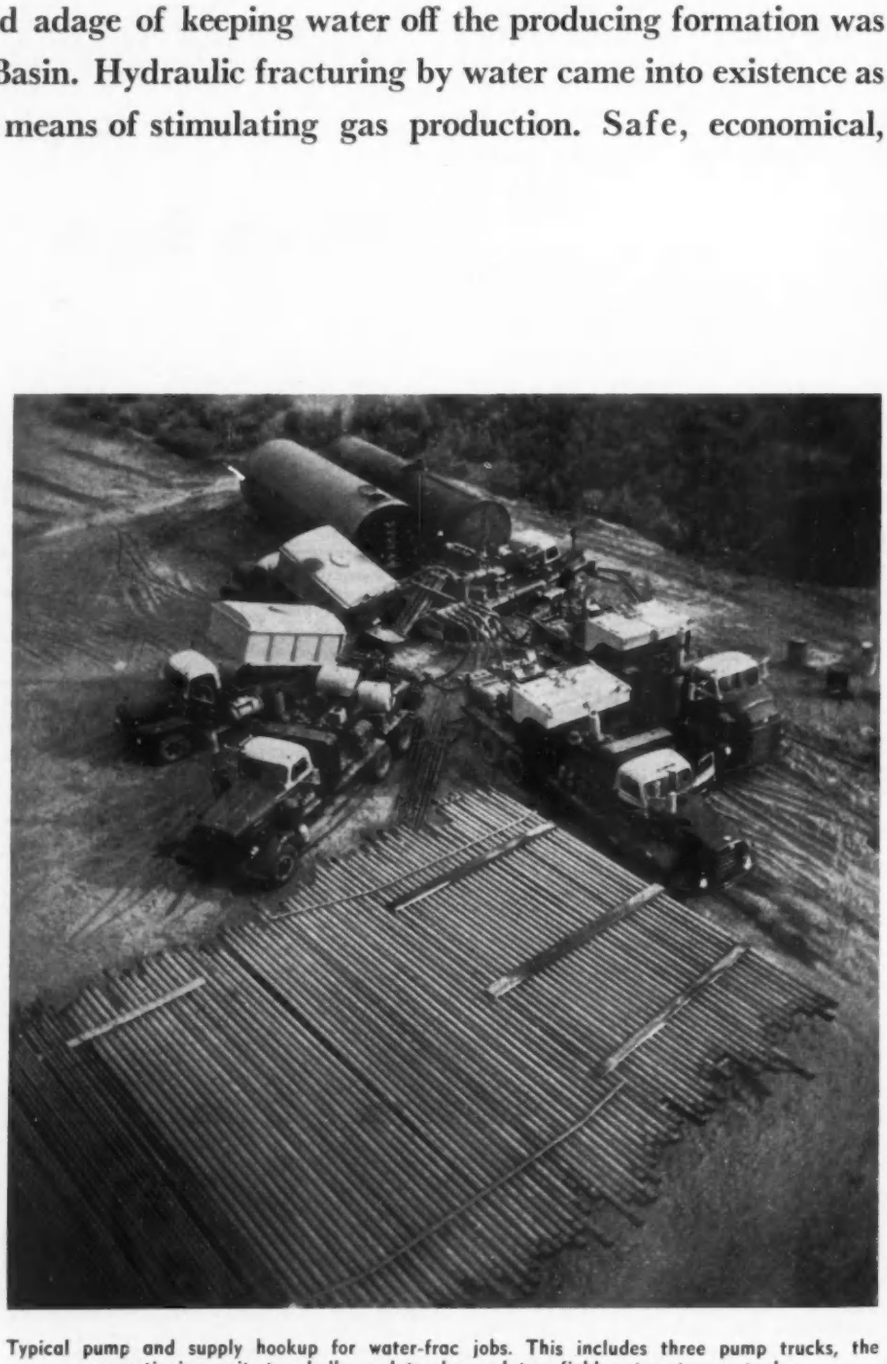
Cumulative Production, 1-1-1955, 228,861.

Fracturing with Water In San Juan Basin

OCTOBER, 1955 . . . the old adage of keeping water off the producing formation was over-ruled in the San Juan Basin. Hydraulic fracturing by water came into existence as a safer and more economical means of stimulating gas production. Safe, economical, and available.

By ED J. COEL, Jr.,
El Paso Natural Gas Company,
Farmington, New Mexico, and

J. B. LIVINGSTON,
Halliburton Oil Well Cementing
Company, Lubbock, Texas



Typical pump and supply hookup for water-frac jobs. This includes three pump trucks, the proportioning unit, two bulk sand trucks, and two field water storage tanks.

DURING OCTOBER, 1955, fracturing techniques in the San Juan Basin experienced a tremendous change. Basically this was a change from the use of No. 2 diesel oil as a sand carrying agent and fracturing fluid to the use of fresh water. This procedure was a result of much thought and consideration during the past year, by the personnel of both the El Paso Natural Gas Company and the service company in trying to find a safer and more economical means of stimulating gas production by hydraulic fracturing. The water is obtained from water wells, rivers, or any other available source, and is being used in an unaltered state.

Prior to the use of water in the fracturing treatment, practically all other types of fluids had been used. Success was obtained with some of these fluids—with others, it was not. In 1951, several treatments were tried using soap type hydrocarbon gels with little or no success. In October, 1952, the first treatment was performed using No. 2 diesel oil as a sand carring medium with good success. The use of diesel oil as a sand

"Workshops on Wheels"

WHAT IT IS: Rockwell's new Mobile Maintenance and Lubrication Service is designed to increase the efficiency and lower the cost of valve maintenance for oil and gas field installations, refineries, pipe lines, chemical plants, and processing plants. It is made possible by a fleet of specially-built valve "workshops on wheels," manned by factory-trained experts, and equipped to provide complete "on the spot" service on a regular schedule, tailored to fit individual needs.

HOW IT WORKS: A Rockwell engineer, thoroughly familiar with Nordstrom valve design and maintenance, as well as with your particular process requirements, studies your installation in terms of its service needs. Then a mutually agreeable schedule is established for the servicing of your valves. From that time on, you have no valve maintenance worries; they become the responsibility of a Rockwell service expert. At regular intervals he will handle all servicing and lubrication quickly, efficiently, working from one of Rockwell's "workshops on wheels." These Rockwell-designed trucks are equipped with the most advanced lubrication, servicing and repair equipment, and built to operate with complete safety under any fire or explosion control requirements.

WHAT IT COSTS: Naturally, the price of this new planned maintenance and lubrication service varies with the size and number of valves, and with frequency of service. Definite prices are established after a Rockwell engineer has studied your individual requirements.

Actually, this new Rockwell service saves far more than it costs. It saves on fixed maintenance overhead. It saves on valve repairs. It saves by reducing costly down time. Because it is expert *preventive* maintenance performed on a regular schedule, it saves by spotting potentially expensive trouble *before* it gets expensive. And, of course, it saves on valve replacement costs because your valves will give you longer, more economical service life.

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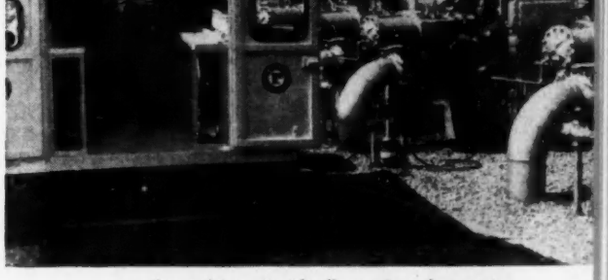

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carrying fluid for fracturing gained momentum from the first job, and by late 1954, it had completely replaced shooting as a production stimulant. From that time until September 1, 1955, No. 2 diesel oil was used in 99 percent of the treatments. The other 1 percent used high gravity crude or distillate obtained in the area.

Drilling and pipe programs for the gas wells are unique in that they differ considerably from the practices followed earlier in the history of the Basin development. At the present time, normal procedure is to set approximately 160 feet of surface casing and approximately 3500 feet of intermediate casing. Water gel or emulsion mud is used for drilling fluid. All drilling fluid is removed from the well by gas, and drilling is continued through the production section using gas as a circulating medium. Production casing, either full strings or liners, is then run and cemented dry. Twenty barrels of water gel are run immediately ahead of the cement, and a balance type cement job is performed. This method of cementing the production casing is done to enable the setting of the casing through the production section without loading the hole with water or mud. This eliminates sloughing and lost circulation problems, and at the same time affords a method of selective perforating and treatment of the sand bodies. Prior to this method, most producers set production casing on top of the pay section with mud in the hole, drilled in with gas, and fractured the formation down the casing or through packers set in the open hole. This gave only semi-selectivity of treatment. The entire open hole was then cleaned out before completion.

Experience in open hole completions had shown that water caused difficult clean out problems due to sloughing of the shales and coals interbedded in the Mesa Verde. Oil used for completions was cleaned out with comparative ease.

However, several wells, in emergencies were killed by loading the hole with water, and none of these suffered any permanent damage due to the use of water. This fact was substantiated by laboratory tests on cores of the various formations. These laboratory testes showed that fresh water was not detrimental to production; thus, when the method of setting casing through the Mesa Verde proved practical, the door was open to using water as a fracturing fluid.

The first treatment of this type was performed by El Paso Natural Gas Company on the Point Lookout member of the Mesa Verde formation in the Blanco field. For an immediate comparison, the Point Lookout was divided into two treatments. Sixty feet in the lower sand portion was perforated and treated with No. 2 diesel oil and sand. A bridge plug was set in the casing to divide the two sections. Sixty-five feet in the upper sand was perforated and treated, using fresh water and sand. The Cliff

TABLE 1—A comparison of fracturing treatments using oil with other fracturing treatments using fresh water on gas wells in the San Juan Basin.

Well No.	No. Treatments Per Well	Type Fluid	Formation Treated	Amount Fluid Gallons	Amount Sand Pounds	Initial Potential MMCF/D
1	1	Oil	Lower Point Lookout	23000	15500	3.6
1	1	Water	Upper Point Lookout	15000	7200	3.1
1	1	Water	Cliff House	22000	2000	2.3
2	3	Oil	Mesa Verde	52000	68100	15.3
3	2	Water	Mesa Verde	81900	86000	12.7
4	3	Oil	Mesa Verde	45800	51000	8.6
5	2	Water	Mesa Verde	60500	57500	9.3
6	1	Oil	Pictured Cliff	7000	10000	6.2
7	1	Water	Pictured Cliff	18000	29500	6.6
8	1	Oil	Pictured Cliff	8900	15000	2.1
9	1	Water	Pictured Cliff	17000	17000	2.1
10	1	Oil	Pictured Cliff	7000	7000	2.2
11	1	Water	Pictured Cliff	15600	30000	3.8

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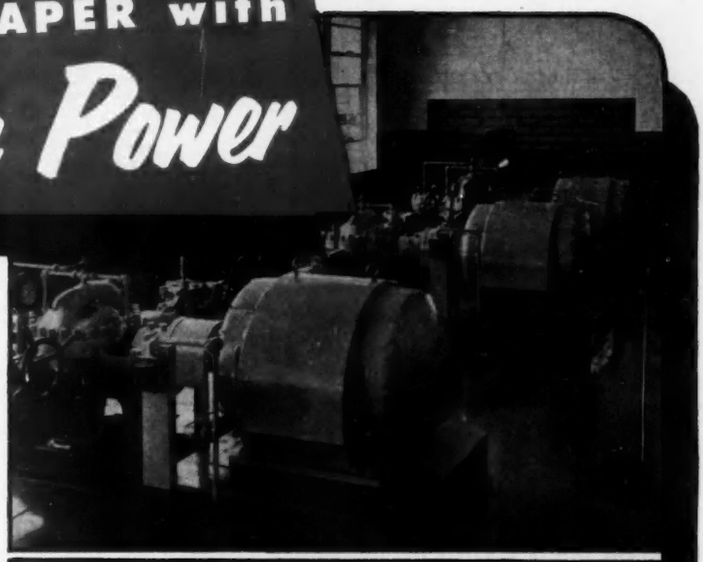

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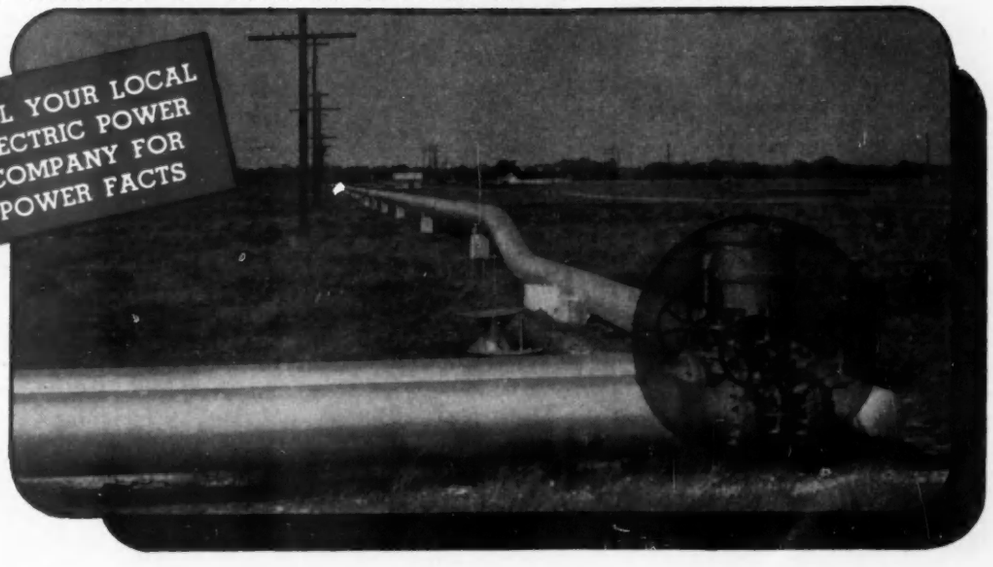

House member of the Mesa Verde was also treated with water and sand. These results were considered favorable (Table 1, Well 1) and warranted further development of this technique.

After successful treatment had been performed on the Pictured Cliffs and other formations in the Basin, the change from the use of oil as a fracturing fluid to the use of water was rapid, as illustrated in Table 2.

TABLE 2—Percent of fracture jobs run each five-day period between September 1, 1955, through October 15, 1955, using water or oil.

DATE	Percent Oil Jobs	Percent Water Jobs
9–1 to 9–5	84	16
9–5 to 9–10	87	13
9–11 to 9–15	33	67
9–16 to 9–20	24	76
9–21 to 9–25	54	46
9–26 to 9–30	38	62
10–1 to 10–5	36	64
10–6 to 10–10	0	100
10–11 to 10–15	5	95

One of the outstanding features of the use of fresh water as a fracturing fluid is its economics. No. 2 diesel oil costs an average 15.5 cents per gallon, delivered on location, whereas the only cost of the water is the transportation to the well, usually 1.5 cents per gallon. One can easily see that this offers a tremendous reduction in the cost of the job, or enables larger treatments to be done at the same cost.

A second advantage is the safety aspect. Using water in the fracturing treatment practically eliminates the fire hazard which was so prevalent during the pumping of diesel oil or other types of hydrocarbons.

The performance of water jobs does not differ greatly from those using oils. There seems to be a trend toward larger treatments using more fluid and sand, and more pumps for higher treating rates. Sand and water ratios average 1.5 pounds of sand per gallon. Treatments are begun with a ratio of $\frac{8}{10}$-pound of sand per gallon and is increased as the treatment progresses until a ratio of 2 pounds per gallon is reached, giving an over-all average of 1.5 pounds per gallon. This change in water and sand ratio, as the job progresses, is accomplished by the use of propotioners, which are mobile units equipped with machinery to mix the sand and fracturing fluid in definite proportions before they are pumped into the well. The devices involved are positive displacement type pumps, called metering pumps, which transfer the fluids from their storage to a mixing reservoir having a capacity of approximately ten barrels. Into this device sand conveyer screws convey the sand from bulk delivery trucks. These sand screws are calibrated with the metering pumps through a PIV transmission. Through the use of the PIV transmission, sand and water ratios entering the mixing reservoir can be changed from $\frac{1}{10}$ pound per gallon to 3 pounds per gallon—or any ratio between—at any time during the progress of the treatment. Since the falling rate of sand in water is so great, the above method of mixing is the most effective means of getting a uniform mixture to the treating pumps. This type mixing also reduces chances of slugging sand into the treating pumps and lessens chances of screen outs in the well bore.

Another feature of the proportioning units is the use of centrifugal pumps, which transfer the sand laden fluid from the mixing reservoir to the suction side of the treating pumps, maintaining a pressure of 10 to 20 pounds per square inch on the treating pump suctions at all times.

Two high-pressure triplex type pumps are provided on each treating unit. Each pump is powered by a 300 horsepower diesel engine. Body load units are used due to the extremely difficult terrain encountered going to and from well locations in the basin.

Specially built steel storage tanks are used to store the water at the well locations. These tanks are equipped with manifolding ample to supply the desired amounts of fluid to the proportioning unit to obtain the desired treating rate.

Sand is delivered to the well in bulk delivery trucks. Here again, the difficult terrain prohibits the hauling of large loads, so body load dump type trucks, which will deliver 20,000 pounds per unit, are used.

A typical fracturing treatment using fresh water and sand is a 50,000 gallon, 50,000 pound treatment used on each member of the Mesa Verde formation. To do this treatment, storage tanks are placed on location and filled with 60,000 gallons of water. As soon as the well is ready for treatment, one seventy barrel per minute proportioning unit, six treating units and 50,000 pounds of sand are moved in and set up as shown in accompanying pictures. All connections and hookups are tested and checked for surface leaks before starting. All units are started, and treatment begins by pumping water without sand into the empty casing. As soon as all units are

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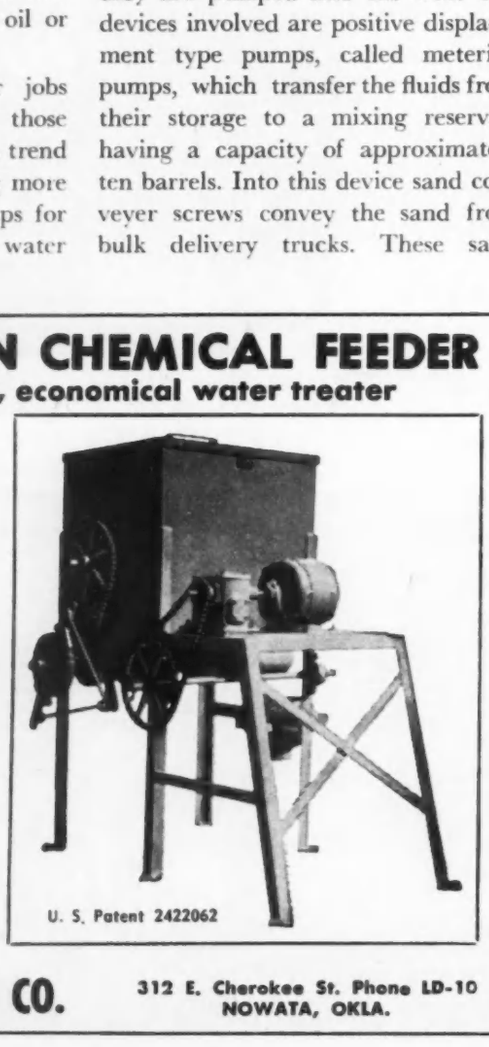

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About the Authors

Coel

Livingston

E. J. COEL, JR., joined El Paso Natural Gas Company in 1949 after receiving his B.S. degree in petroleum engineering from the University of Texas. He has been in Farmington, N. M., for the past five years, being named senior petroleum engineer three years ago. He is registered with the New Mexico Board of Professional Engineers.

J. B. LIVINGSTON received a B. S. degree in math and chemistry from Wofford College in 1942 and, after serving four years in the armed forces, joined Halliburton Oil Well Cementing Company in April, 1946. He has worked in various capacities with the company serving as division engineer since 1952.

---

operating properly, the sand is then started into the mixing reservoir and the job continues until the sand laden water is displaced through the casing perforations by water. Strict coordination is exercised to insure the completion of the operation without a shutdown. A stoppage usually results in sand clogged treating pumps or a sand blocked well, or both. Treating rates of 40 to 60 BPM are usually obtained and approximately 25 to 35 minutes are required for the entire treatment.

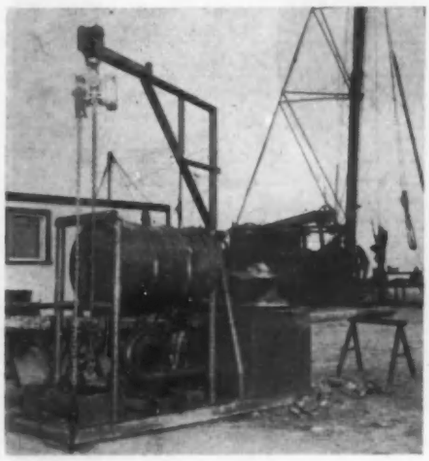
Water, in addition to being safer and more economical, is easier to handle and provides higher hydrostatic heads resulting in lower treating pressures. Therefore, higher injection rates needed for larger sand concentrations, and fracture extensions, are more easily obtained.

It could be that water as a fracturing fluid need not be limited to the stimulation of dry gas sands, or to the San Juan Basin. —**The End**

How to do it

PRODUCTION HINTS

$10 is paid for each illustrated acceptable contribution. Mail to The Editor, WORLD OIL, P. O. Box 2608, Houston 1, Texas.



Skid-Mounted, Unitized Forge Simplifies Bit Dressing

A skid-mounted forge which incorporates the fuel tank, blower, forge, quenching bath and chain hoist to shift bits was rigged up by the welder of a West Texas cable tool operator. The bits are heated in the forge, then hoisted and swung around to the side to the dressing station. After dressing, they are swung around to the back and placed in the quenching bath.

Each component is built up from the skid base which is made of I-beams with 3-inch pipe across the front and I-beam braces across the middle. On the front end of the base is the steel box in which the fire brick are placed. The blower, mounted in the center of the platform, is aimed into the lower part of the box. The fuel tank is mounted on a frame just above the blower and the ½-inch outlet is connected to the blower line so that fuel is picked up by the air stream going into the forge.

The front end of the frame, which supports the fuel tank, is extended upward to make the cantelever beam for handling the bits. It is made from 3-inch pipe and braced. A track, welded on the outer end of the beam, supports the chain hoist which is mounted on a roller so that the bits can be moved endwise approximately two feet.

The quenching bath is added by taking a piece of 12-inch pipe, cutting it in two and welding it in between the plates welded to the I-beams. Inside the trough are the usual runners made of 2-inch pipe on which the bits are set.

The first photograph above is an over-all view of the bit dressing assembly showing the bit being heated in the background. In the second photo, the bit has been removed from the forge and placed on the anvil and the dressing operation is in progress. After dressing and reheating, if necessary, the bit is swung in the arc and placed in the quenching bath until ready for use. As shown in the third photo, the hoist is then used to lift the bit and place it on the bit buggy to take to the rig floor.

Raise Jack Circle to Facilitate Bit Changing

On clean-out rigs, where the wells are apt to kick off and flow during operations, an oil saver above the master valve is necessary so the well can be controlled with the wire line in the hole. To save cutting down height of the casing head or raising the derrick floor to operate the tongs, one company raises the jack circle so the tongs will work on top of the oil saver.

The circle is tack welded to 13½-inch thread protectors from surface casing, with one protector under each end and one in the center providing a firm support. When the tongs are put onto the squares on the drill tools, they are high enough so that they can be operated easily with the jack operated from the circle.

Call **UNION TANK**—your wells start earning

REVENUE FAST

with UNION'S quick service on production equipment!

When you need equipment for your next well, call your Union Tank representative — and begin earning revenue in a hurry. Day or night, he can start tanks, separators, heaters, treaters, and other equipment on the way to your leases from a nearby stocking point.

Sales and service teams experienced in supplying equipment for wells in your area will assist you in determining the proper equipment for your particular well.

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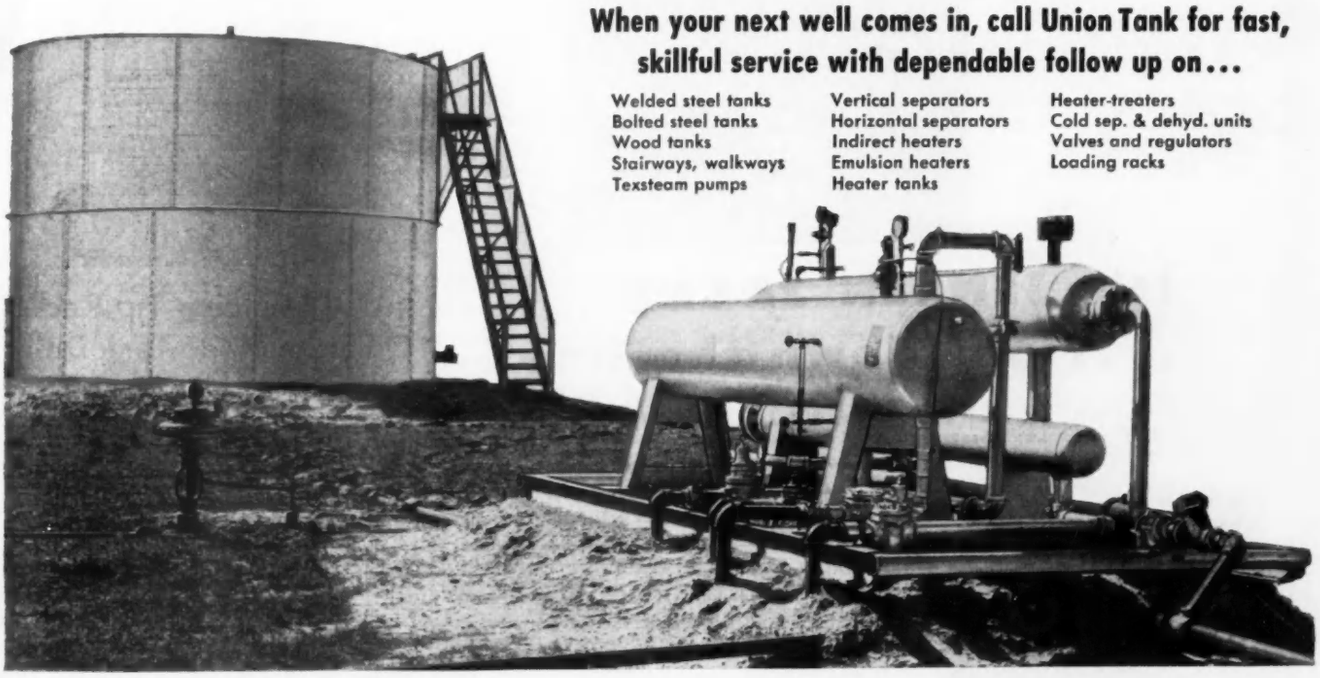
- Loading racks



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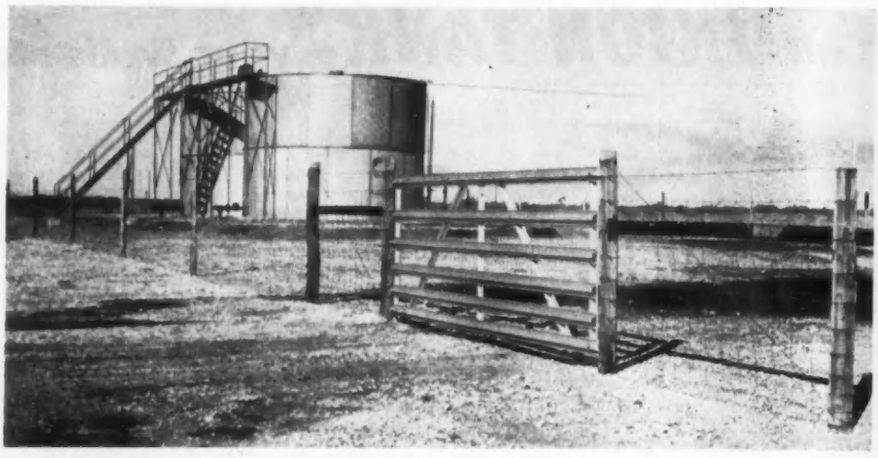
Use Aluminum Gates In Corrosive Areas



In various oil field areas hydrogen sulfide corrosion is very severe and metals that do not even come in direct contact with the fluid can be corroded because of corrosive elements in the air.

To decrease maintenance costs around the tank battery, one operator uses creosoted wooden posts in place of metal posts. Gates to the tank batteries are made of an aluminum alloy that does not corrode and does not require the painting that steel gates would. With the hinges also made of this aluminum alloy, the operator does not have the frequent painting and maintenance jobs commonly needed in these areas.

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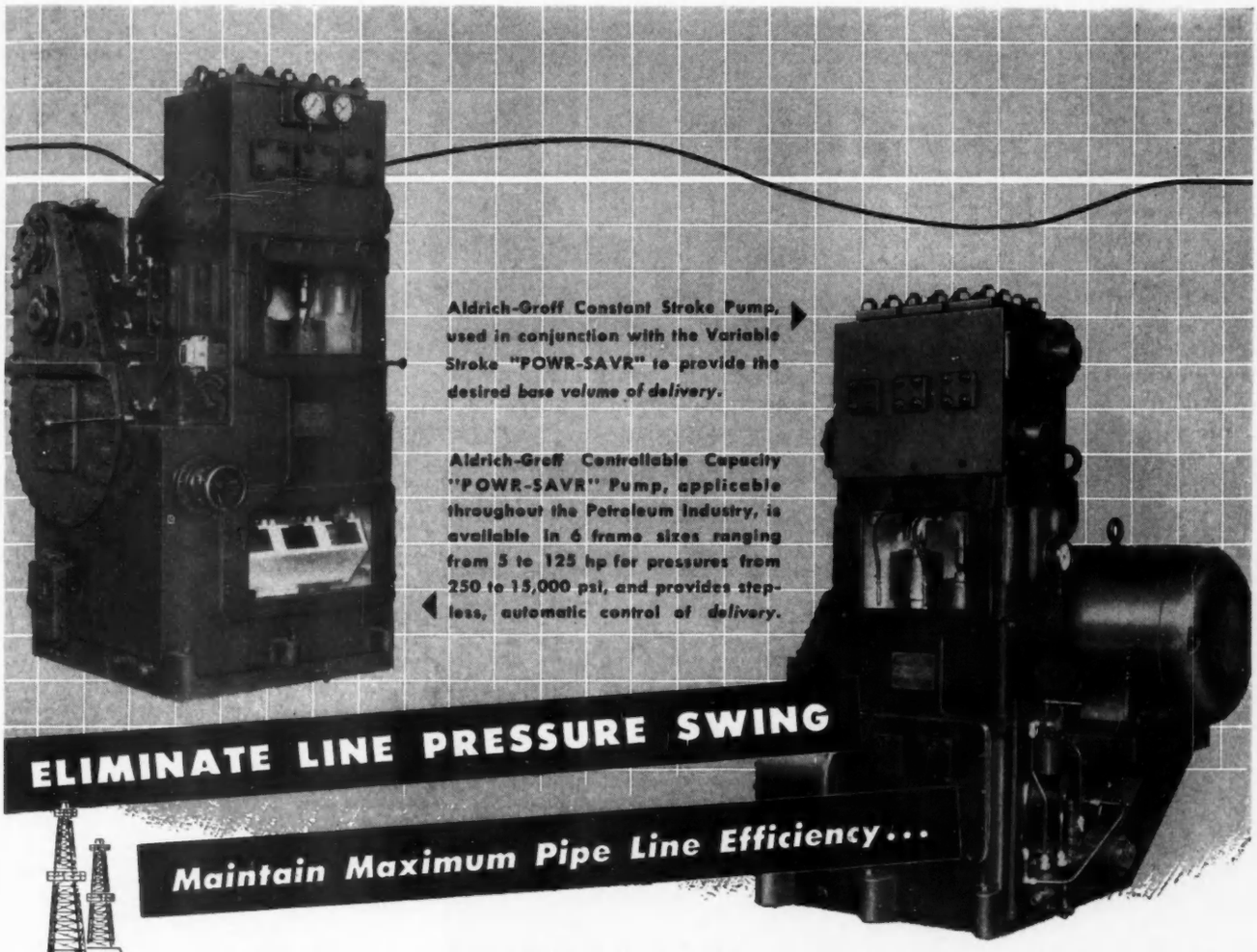
Use a chain with attached turnbuckle to hold the racks to the tanks. Use construction reinforcing metal brackets to hold the hoses when not in use.



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Temporary Cattle Guard Saves on Location Costs

Temporary entries to a drilling location are sometimes more convenient and accessible to highways than the main lease road. To keep the cost of the temporary gates at a minimum, one producer uses a narrow, lightweight cattle guard that can be removed easily. This saves expense, both in materials and transportation, of the larger cattle guard that ordinarily is used to accommodate heavy trucks.

The cattle guard is made garage width so only passenger cars can go through. Beside each guard is a gap which can be taken down when heavy equipment is being moved.

At the main entrance to the lease a heavy cattle guard is installed. When guards would be used only during drilling operations of a well, they are made by welding boiler flue material over two cross pieces and welding an upright post to each end for the fence to tie to.

IT PAYS TO USE ENARDO* SLIP-ON* FITTINGS . .

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Slip-on fittings eliminate flanging, threading, welding; saving hours of installation time. No special tools or skill required to install, and all Slip-on's are reclaimable. Every joint is a union, making it easy and inexpensive to take a line apart. They permit misalignment up to 11°, absorbing shock, ground motion, expansion and contraction. They are recommended for permanent installations. Write for catalog page 11-01.

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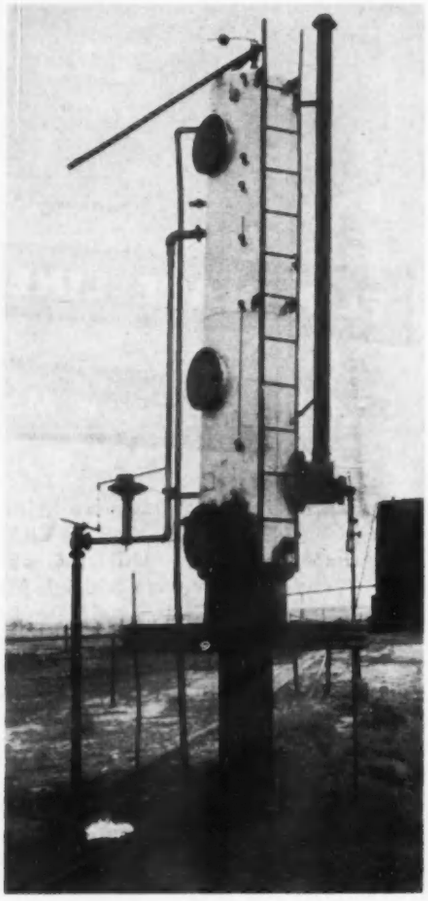

Old Bull Wheel Serves As Separator Stand

To operate at lower pressures and still increase wet gas recovery by providing gravity flow to the stock tanks, mount separators on old bull wheels and save the expense of fabricating a stand. Turn the wheels on their side, level them up and place the separator on top. Then extend the lines to the raised heater-treater-separator which will be high enough so that no pressure is required to force oil over into the tanks.

"TYPE E-5"
Available in 4½" to 5½" casing sizes to support 2" to 3" tubing. Very compact, measuring only 9½" in height. Ideal for short hook-ups on medium depth wells.

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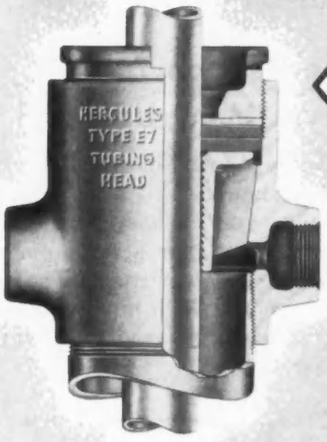

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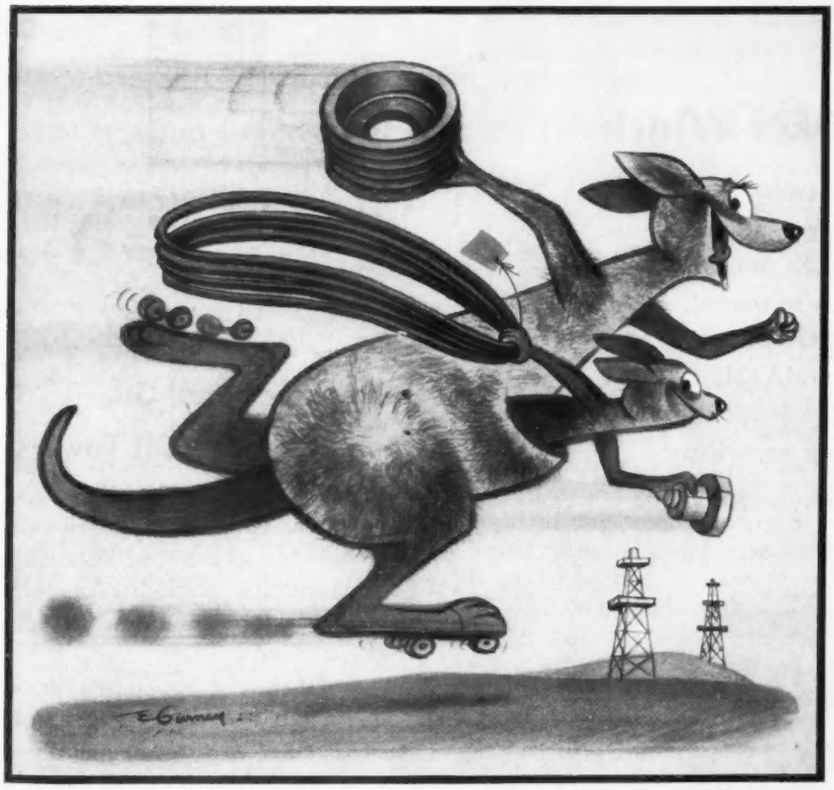

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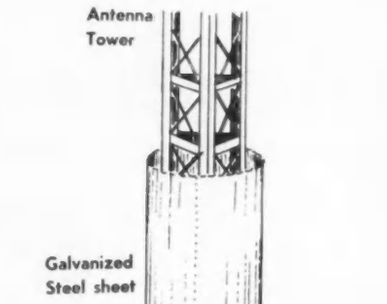
Pipe Rack on Truck Serves Many Uses

The pipe rack shown here can be used for hauling small diameter pipe; yet, at the same time, it can be used as frame work for a tarpaulin when needed as a crew truck. The frame work is of one-inch pipe with the exception of the peaked roof, which is of ¾-inch pipe.



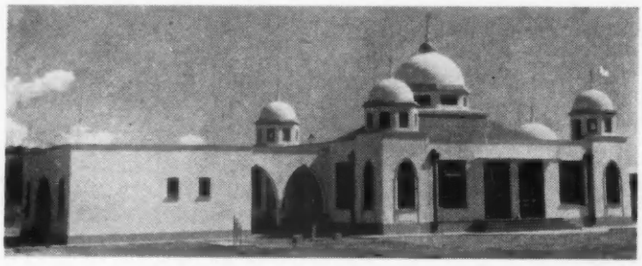
Galvanized Steel Guard Keeps Children Off Towers

Unguarded pipe line radio towers could be the cause of injury to children and damages to the company. To prevent the possibility of such accidents, a foreman fabricated the sheet guard shown.

Three sheets of galvanized drain roofing about ten feet long were fastened together to form a cylindrical guard around the tower. Cost of protection is less than $5 per tower.

A Camp-City Profile

This feature, one of a series describing important oil camps or cities throughout the world, is intended only to describe living conditions and to give a bit of the local atmosphere. While an occasional one of the features may touch lightly on working conditions, it will do so only incidentally.



Oil company gifted the Muslim community at Seria with this mosque. Shown at right is marine drilling location recently spudded. It is first of four exploration wells being drilled. Seria oil field today spreads out beneath the seas around Brunei's coast.

Tranquil Seria: Southeast Asia's Industrial Center

Carved out of the Borneo jungle, this oil city stands as an isolated but pleasant tribute to the men who find and produce the world's oil.

By GEOFFREY KERR,
British Malayan Petroleum Company,
Seria, British Borneo

OIL TOWNS the world over have one thing in common, at least: tremendous human energy and vast sums of money were required to create them in areas where, for natural and other reasons, little or no development would have taken place were it not for oil.

And The British Malayan Petroleum Company's oil field at Seria, British Borneo, stands out among the outstanding as a monument to what men and money can achieve in alien surroundings.

Seria is about as far from supply centers at it is possible for an oil field to be—8000 miles from Europe and about the same from America. It has no nearby deep-water port. Every nut and bolt that comes in must be transferred from ocean-going ships at Labuan, 65 miles away, and brought to the oil field by shallow-draught coastal vessel. The nuts, bolts and other requirements blossom into about 12,000 tons of cargo each month, which is itself a measure of the effort that has created a large sized town virtually in the middle of nowhere.

British Borneo is composed of the colonies of Sarawak and North Borneo and the British-protected State of Brunei, the location of Seria field. The 1500-mile coastline of the territories consists mainly of low-lying swampy plain, with largely uninhabited jungle running down from the mountainous interior to meet the sea. Forests have grown riotously for centuries, and from ground level to treetop they form a network of interlacing vegetation.

Cut down the jungle with immense toil, and what is left is an area of extremely smelly swamp, into which a man or a machine can easily sink out of sight.

Seria has been built and developed under these conditions. Over the last few years, a slice 11 miles long and a mile wide has been slashed out of the jungle, and the resultant 11 square miles of swamp have been filled with something like 7 million tons of sand. Southeast Asia's largest industrial unit

View of industrial part of Seria oil field. This had been jungle, growing riotously for centuries down to the sea.

has grown up on the site, along with its social accessories.

Oil history in British Borneo dates back to the early years of this century, when the Shell Group discovered and developed an oil field at Miri, Northern Sarawak, in a small coastal pocket of hilly ground. Exploration radiated out from Miri (which is still a producing field today), and by the middle 1930's it appeared that a large oil field probably existed about 40 miles further along the coast at Seria, in neighboring Brunei State.

By the outbreak of World War II, development work had been carried out in the swamps and jungle of the Seria area, and about 5 million barrels of oil was being produced each year.

Then Japanese invaded British Borneo. Production facilities at both Miri and Seria were extensively damaged to deny them to the enemy. For four years the area was in Japanese control.

Some rehabilitation was carried out by the Japanese during that period. But Commonwealth and U. S. air and naval activity prevented much oil being sent from Borneo to Japan. Skeletons of bombed and torpedoed Jap tankers still litter the shallow seas around the Borneo coast.

Finally, the Japanese abandoned their rehabilitation attempts when the atom age blossomed at Hiroshima, did as much damage to the oil fields as they could, and were driven out of the area by Allied advance.

Australian forces were the first Allied troops ashore at Seria, and they found the place a shambles. Wells were burning, most buildings had been blown up or fired, and the local population had been so neglected, medically and nutritionally, that it was almost incapable of heavy work.

Present-day Seria has grown out of this shambles—and during the first half of 1955 has been undergoing a bloodless social revolution which marks emphatically the transition from the pioneering rehabilitation days to those of settled maturity.

Behind the emergence of today's Seria lies a pioneering story as impressive as any in oil's century-long record.

First priority after Japanese were driven out of Borneo was to bring the burning oil wells under control and re-establish production. With the help

Pleasant beach resort shows how in places the Borneo jungle marches right down to the South China sea.

Temporary staff club of wood and palm thatch, at Seria, is being permanently rebuilt elsewhere with swimming pool.

of army equipment and U. S. fire-fighting experts, that was done. Thereafter, until supplies of oil field equipment began to trickle through the 8000-mile supply lines, miracles of improvization restored a degree of production and kept the oil flowing.

For example, ordinary domestic water pipe fittings and tubing had to be used as high-pressure flowlines—and stood the test. Gasoline was desperately short in the midst of plentiful oil—and so a hair-raising "refinery" was built to tide over the worst period. Hub of the unit was an abandoned Jap water-tube boiler, in which crude was distilled while operators anxiously stood by.

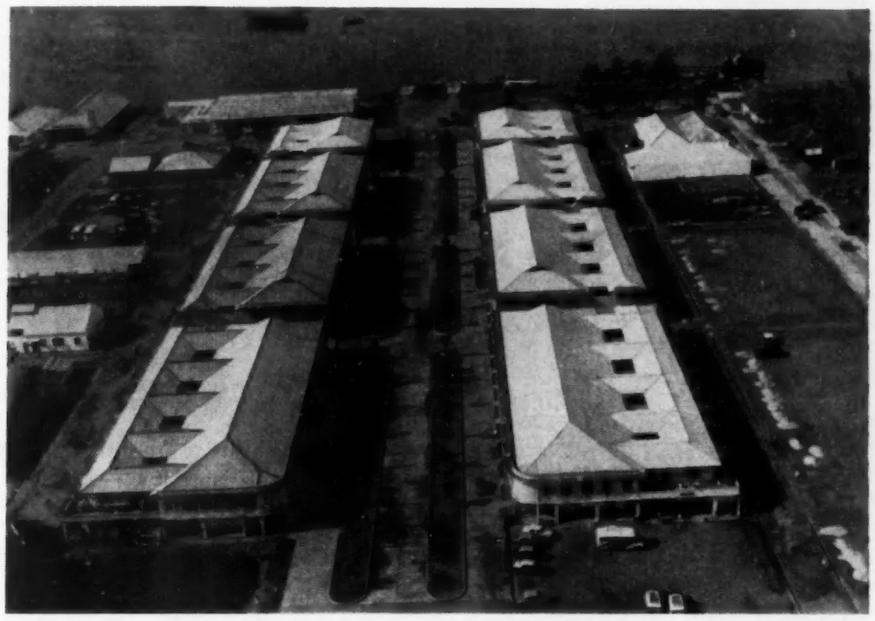
After months of improvization, new equipment began arriving fairly regularly. Although rehabilitation of Seria had been planned long before the end of the war and necessary orders had been placed, munitions work held up their completion and the world shipping shortage delayed delivery.

In due time, however, production facilities reached something like normality. But the Commonwealth was by then short of U. S. dollars. A decision was taken to expand Seria field as quickly and as extensively as possible to boost supplies of non-dollar crude.

What was to all intents and purposes an area of a few oil wells in jungle clearings linked by sand tracks was to become a full scale oil field. Square miles of jungle were torn down. Millions of tons of sand from beaches were carried and pumped to fill the exposed swamp. Temporary buildings began to spring up, ranging from wood and palm-thatch houses—for early workers—to stores and engineering workshops; from hospital to an open-air theater; from a commissary to clubs for the various nationalities of workers who began to stream into the area from throughout the world.

Within the past few years, while production and exploration have been maintained, the emphasis has shifted to bringing the social side of the oil field into line with its industrial expansion.

Members of a newly-arrived family, after orientation, find they are living in a narrow belt of highly-developed territory between the South China Sea and the untouched jungle. They will find the climate hot and humid, though not unbearably so. They will find days and nights of equal length. They will enjoy most of the amenities of city life found elsewhere in the world, boundless social and sporting activity . . . and a lot of hard work still to be done.



The Kuala Belait bazaar, Borneo shopping center near the Seria oil field.

For out of the postwar blazing mess of oil fields in jungle clearings has developed a community of permanent and orderly housing estates, modern store buildings and well-equipped workshops, and a throbbing intercommunal life of its own.

Above all, the family will find an object lesson in racial harmony. Workers of Seria are drawn in substantial numbers from most of the races in Asia, yet live and work together harmoniously.

Seria's working community is composed of about 400 European supervisors, 2500 Malays, 2400 Chinese, 1500 Indians, 700 Dayaks, and about 250 "others," representing smaller communities of other Asian races. Many of the 7750 employes have their wives and families with them, and the total oil field population amounts to about 18,000.

Depending directly upon the oil field for their livelihood are about 3750 more families—shopkeepers in the local bazaars, contractors and their staffs, government officials, and the expatriate staff of the larger commercial organizations—giving the Seria area a total population of about 30,000, half the population of Brunei State.

The organization of the oil field follows the pattern of any other town, that the isolation of the place makes it necessary for the oil company to operate many "municipal" services that, elsewhere, would be provided by the government.

The oil field, for example, generates all its own electricity; has its own domestic gas installation; pumps, filters and distributes its own water; runs its own hospital, mail services, fire trucks and garbage collection; operates its own road, rail, sea and air transport systems; and has its own highly-developed social welfare services.

Members of an average household rise at about 5:45 A. M.—the coolest part of the day. They live in a concrete or a wooden bungalow rented from the company, complete with water, gas and electricity at a rent ranging up to U.S. $15 per month, according to size and type.

Working hours are from 6:45 A. M. to 4 P. M. on Monday to Friday, with a lunch period from 11:30 A. M. to 1 P. M., and from 6:45 A. M. to 11:30 A. M. on Saturday.

Four schools are located in the Seria area: One run by the company offering European style education, another a Catholic mission, and the other two are Malayan and Chinese language schools. All are served by company busses. The mission and Chinese schools receive financial support from the company. The Malay

Asian youths train as artisans in trade school operated by the oil company.

school is run by the Brunei government.

Many oil field families have cars, and housewives shop at the company's commissariat, a recently opened air-conditioned supermarket. At busy periods the commissariat is a colorful pageant of the women of the world, many in their own national costumes.

There are six clubs in the oil field: one for European and Asian senior staff, one for senior Asian staff only, and one each for Malay, Dayak, Chinese and Indian workers. There is no planned segregation behind this diversity of clubs. Different Asian races have dietary taboos and language differences which are most conveniently observed by offering separate premises.

Weekend routine varies. For most oil field workers are free Saturday afternoon and Sundays. Sports include sailing, rowing, cricket, soccer, rugby, football, golf, tennis, badminton, basketball, volleyball, shooting, swimming, athletics, hunting in the jungle—whatever is appropriate to season and national taste. Those less vigorously inclined turn to the miles of beaches, books or gramophone records from libraries maintained by some of the clubs, or . . . just relaxing in the sun.

Weekends are perhaps the busiest social times, when shows and entertainments may be staged at the oil field Community Hall by the local Amateur Dramatic Society, or one of the cultural groups associated with people of a particular nationality.

This is the routine day-to-day life of Seria, and it applies in varying degrees to all who live there, for (making allowances for national idiosyncracies) the same broad facilities are open to all.

Naturally and understandably, people of different nationalities do tend to group themselves together and pursue their own special interests and cultures. This occurs in Seria, and although on high days and holidays—such as club and athletic events—there is pretty free inter-mixing, normally the communities follow their own interests with mutual toleration and respect.

Several points indicate the success with which the mixed races of Seria live and work together. The Brunei government's annual report, for instance, comments that crime is rare and industrial friction entirely absent in the oil field area.

In a sphere wider than the oil field, all Brunei State repeats a satisfactory state of affairs. To the man in the street, one of the most pleasing indications of Brunei's peace and prosperity is the fact that no personal income tax is imposed—though registered companies pay 30 percent on their profits. As a result of stepped-up oil operations, Brunei's state income has risen from the equivalent of about $6.5 million in 1950 to about $31 million today—small by standards of international finance but good for a country with a population of only about 55,000—of whom only about half depend upon the State for the provision of costly public and social services.

Brunei's oil revenues are being spent on a Five-Year Development Plan which aims at modernizing the state outside the oil field area, and converting it into southeast Asia's first true welfare state: free education, health and social services for all, subsidized electricity and water (drawn, in Seria, from the oil company's installations), pensions for all unable to work, and a vast improvement in communications between the state's jungle-ringed towns and villages.

Brunei State, in wise application of revenues and its happy relations with the oil company, is one of the best examples of practical public relations existing in the oil industry today.

Seria oil field of British Borneo is no idyllic place. Day-to-day annoyances and frustrations arise there as they do elsewhere. To Europeans and Americans, the climate is sometimes an unfortunate tribulation. But there are few thinking members of any of the races who work there who would disagree that the community is an oasis of toleration and tranquility in troubled southeast Asia today.

People of many races, of even more religions, and with widely differing social, technical and economic backgrounds are proving every day that good living and working conditions and wise administration can set aside any basic differences of nationality or small communal differences.

If you don't mind comparative isolation—and most people are too busy to notice it—Seria oil field today is an extraordinarily pleasant place to live and work. **—The End**

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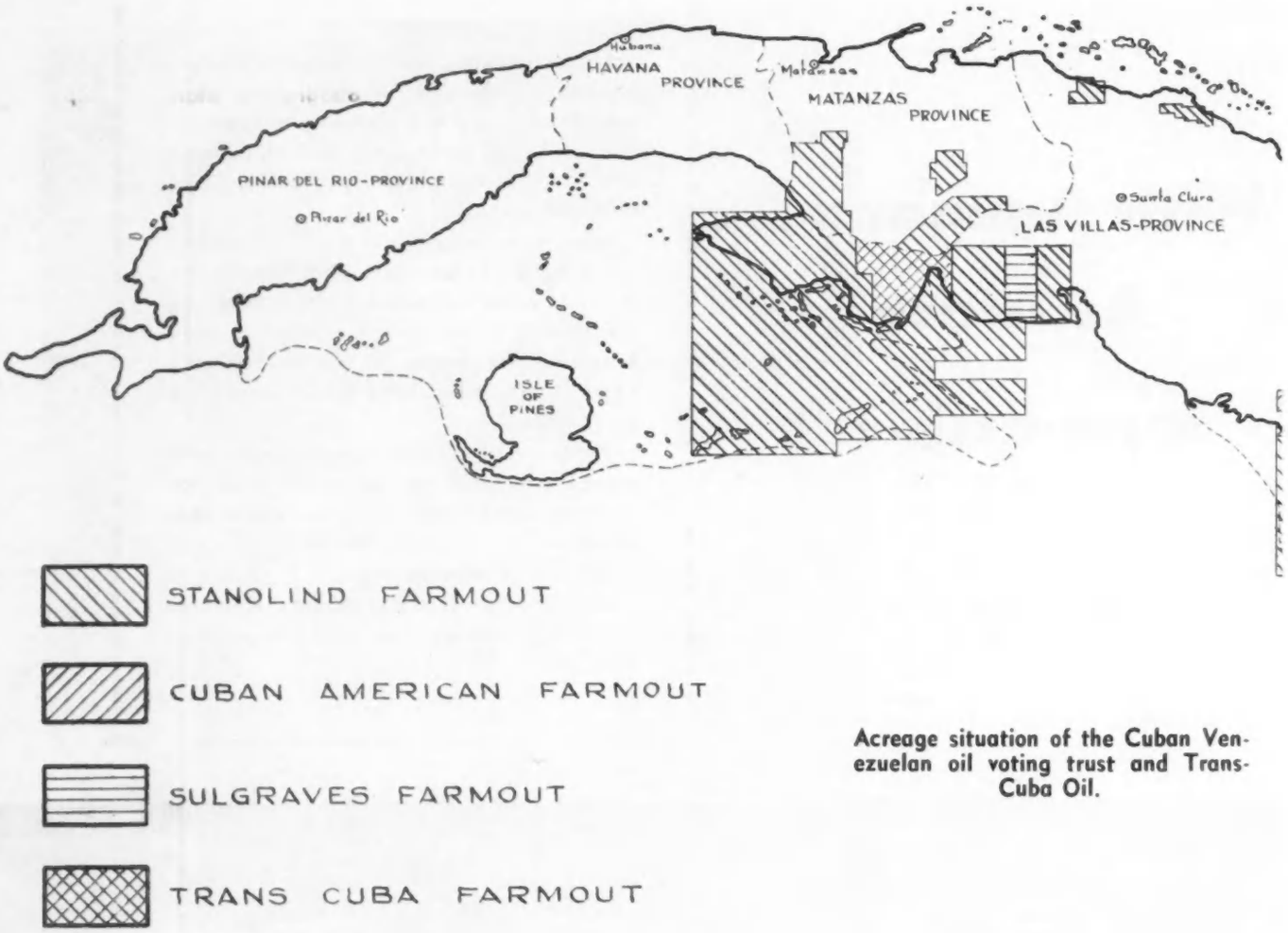


Acreage situation of the Cuban Venezuelan oil voting trust and Trans-Cuba Oil.

Cuban Deep Test Proves Up Basin

Here is the stratigraphy, structure and acreage situation in the recently-discovered Central basin.

By HARRY WASSALL,
Consulting Geologist
Havana

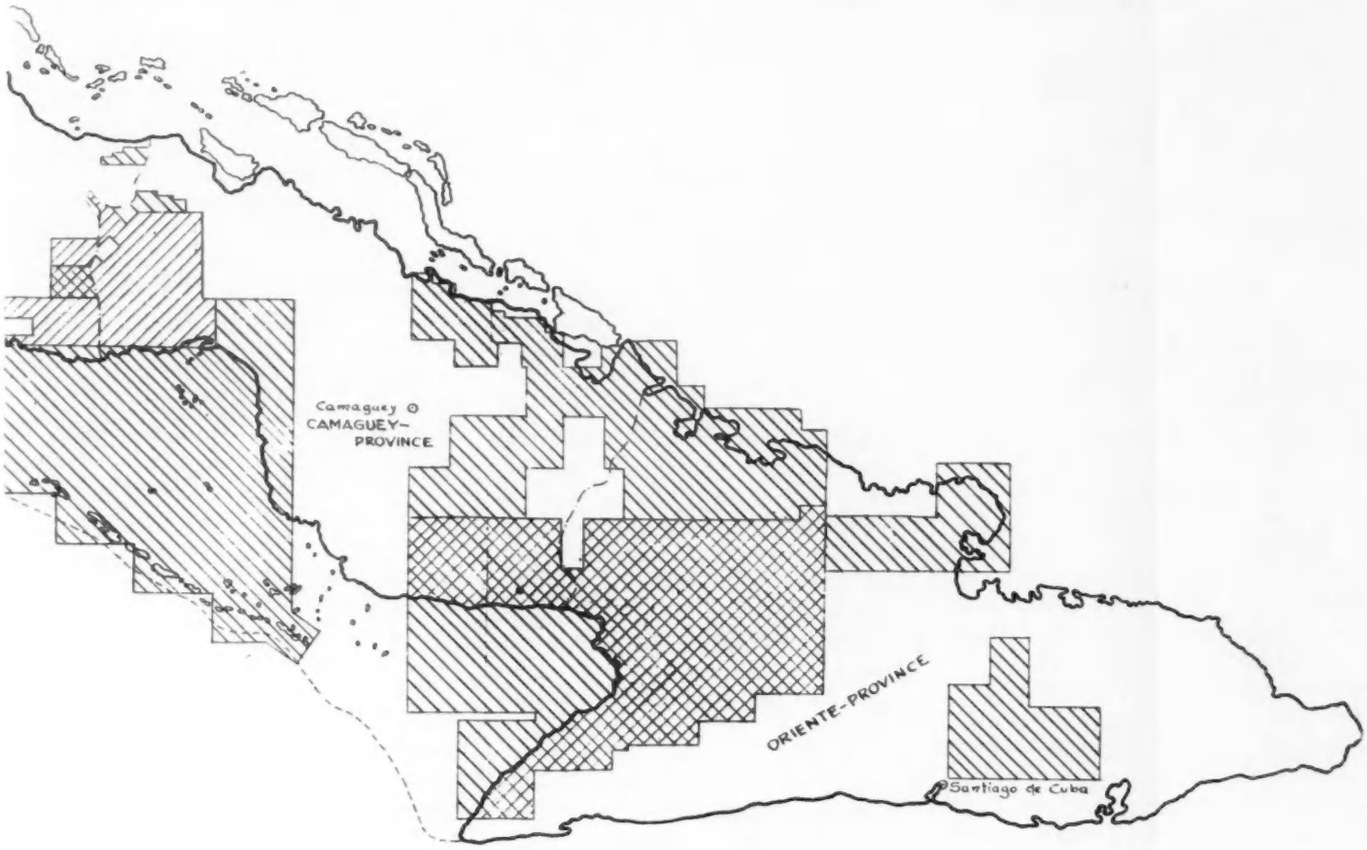
In August, 1955, Trans-Cuba Oil Company bottomed its Sancti Spiritus 1 at 10,118 feet in Lower to Middle Eocene for the first deep test in the newly-discovered Tertiary basin south of the Jatibonico field. Importance of this test is that it opens for exploration a thick section of gently folded marine sediments which offer much better objectives than the complex older rocks.

This basin has been referred to both as the Jatibonico and Central Basin, but the term Central Basin is preferred because Jatibonico field is not situated in the basin but rather on its edge.

Trans-Cuba's third effort in this area is about 10 miles southeast of the town of Sancti Spiritus in Las Villas Province. It was spudded in on May 28, 300 feet of 13⅜-inch surface casing was set, and drilled to total depth with an 8¾-inch hole. No commercial shows of oil or gas were noticed by the well logging trailer or by an analysis of the electric log.

Although unproductive, Sancti Spiritus 1 proves existence of more than 10,000 feet of gently dipping, marine Tertiary sediments and confirms seismic work which indicates as much as 15,000 feet of Tertiary in nearby areas of the basin. Enough porous sands were found to confirm the attractiveness of the area, and another test, Sancti Spiritus 2 was spudded in in September and was drilling below 5300 feet in Tertiary sediments at mid-September 19, 1955, at a location about 4½ miles to the west-southwest.

Stratigraphy. Stratigraphy of the Central Basin is known only from well samples. It consists of less than 2500 feet of Miocene and Oligocene limestones and marls, below which lies a monotonus section of blue-gray, silty shales, which have erratic sand sections which may add up to as much as 600 feet of sand. These



for Exploration

shales and sands range from Upper, Middle and Lower Eocene in age.

Because of the absence of reliable lithologic markers in the section drilled so far, correlation will depend almost entirely on paleontological methods. Now, most wells have had only paleontological spot checks, and accurate correlations will have to wait until exact tops are picked. One problem is the difficulty of separating the Lower and Middle Eocene faunas in Cuba, but detailed studies will probably yield faunal zones suitable for correlation.

On basin edges the stratigraphy consists of volcanics, granodiorite and metamorphics to the west. To the north, the Miocene, Oligocene and Upper Eocene are about the same as in the basin, but the Lower to Middle Eocene is entirely different. From top to bottom it consists of hard limestone, shales and sandstone, and finally a basal conglomerate of volcanic and granodiorite fragments overlying the Cretaceous volcanics.

In Sancti Spiritus 1, limestone was missing, but the lower part of this hole is correlative to the outcrop section, of shale sandstone and conglomerate. This basal conglomerate is wide spread, being present in Trans-Cuba's, Algodones 1 and in outcrops between Jatibonico and Ciego de Avila. However, it is interesting to note that it is not present in any of the Jatibonico field wells, suggesting

About the Author

HARRY WASSALL, a graduate of the University of Tulsa, served in the Navy as engineering officer on LSTs in the Pacific during World War II. He was a subsurface geologist with Shell Oil Company in Wichita Falls, Texas, until 1951, when he joined Gulf Oil Corporation in Cuba. He left his position as acting chief geologist with Gulf in April, 1955, to open offices in Havana as a consulting petroleum geologist.

that this area was a topographic high in Lower to Middle Eocene times.

To the east a very thin section of Tertiary is present in Trans-Cuba's Júraco 1. There only 900 feet of Miocene and Oligocene were recorded with the Eocene being completely absent. In Trans-Cuba's Algodones 1, after 500 feet of Miocene marl and 600 feet of Lower to Middle Eocene conglomerate, Upper Cretaceous shales were found from 1100-1600 feet, overlying Cretaceous basalts. These shales are identical in lithology to those of the Lower to Middle Eocene. They are not known elsewhere, and it is suspected that they may be Tertiary with a reworked fauna. But it is quite possible they are part of an Upper Cretaceous shale basin which is covered by Tertiary outcrops.

The pre-Tertiary rocks have not yet been reached within the basin. However, it is logical to assume they will consist of the same highly folded and faulted Cretaceous flows, tuffs, agglomerates with some interbedded limestones as were found in tests to the north and east. It is possible that to the west the Tertiary may be underlain in part by the granodiorite or metamorphics of the Trinidad mountains.

Structure. Probable limits of the basin are shown in Figure 1. It is bounded to the west by the granite and metamorphics of the Trinidad mountains and a wedge shaped outcrop of Cretaceous volcanics north of Sancti Spiritus. The northeastern part of the contact is a major fault, with the Tertiary eroded off the upthrown western block. It is suspected that this fault continues to the southwest along the eastern edge of the granodiorite and metamorphics, until it is overlapped by the youngest Tertiary along the south coast.

The northern limit of the basin probably is the east-southeast trending fault system (hereby named the Guayos fault zone) which is mapped north of the Trinidad mountains where it separates the granodiorite from Upper Cretaceous and Tertiary sediments. The Guayos fault zone can be traced in the Lower Eocene outcrops, northeast of the town of Sancti Spiritus, to a point where it is covered by the post faulting, flat-lying Miocene and Oligocene.

However, a projection of the fault zone to the east-southeast, separates Jatibonico field, which has a thin (1100-2300 feet) Tertiary cover, from American Leduc's, Echevarria 8, the 4500-foot dry hole south of the field which was the first test to discover the existence of the thick Tertiary basin.

A comparison of this section with those found in Jatibonico field wells indicates a displacement of at least 3000 feet. Cuban Colombian et al's, Norita 1, another 4500-foot dry hole to the Tertiary, falls south of this fault zone, as it should. North of the zone where the Tertiary sediments are exposed they are much thinner than in the Sancti Spiritus 1.

To the east the basin is in part limited by Trans-Cuba's Júcaro and Algodones tests, which found the Cretaceous volcanics at very shallow depths. However, between the Trans-Cuba's Algodones 2 and Jatibonico field, there is a minimum gravity trend which strikes in a northeasterly direction and which cuts across the southeast trending northern fault boundary. This may well be a tongue of the basin, as experience suggests that the Tertiary sediments are thickest in the areas with regional gravity minimums and that the gravity maximums, at least in this area, occur where Cretaceous basalts are nearer the surface.

This tongue may be a narrow graben, as details in the Jatibonico field indicate a northeasterly trend of cross faults parallel to the axis of the gravity minimum. The field itself is a horst bounded by cross faults which strike into the Guayos fault zone, but do not have the same magnitude of displacement.

The southern limit of this tongue as well as the eastern limit of the main basin may likely be a transgressive overlap against truncated Cretaceous volcanics, although it may also be controlled by faulting.

As mentioned in the discussion on stratigraphy, the marine shales of Upper Cretaceous age found in Trans-Cuba's Algodones 1 at 1100-1600 feet, are lithologically identical to Eocene shales of the basin, and it is possible they may account for part, or even all, of the thickening of marine sediments indicated by the northeast trending gravity minimum. If so, this minimum may represent an older basin, and may form part of the eastern limit of the Tertiary Basin.

The southern limit of the basin is unknown, but an east-west trending gravity maximum along the southern coast may indicate a high of Cretaceous volcanics which may separate this basin from another one indicated by gravity work in the shallow water shelf area.

From the relatively scanty information known so far, it appears that faulting is mainly responsible for the formation of the basin and that sedimentation contemporaneous with deposition caused the great increase in section on the down thrown side. This down warping and filling appears to have been most active during the Lower to Middle Eocene, and to have terminated by Upper Oligocene or Miocene. The small amount of paleontological information available on the few wells in the basin suggests correlations which would result in a north dip in the vicinity of the Guayos fault zone. This conflicts with seismic data farther away from the fault which indicates a regional south dip in all the Tertiary section.

The principal objectives in the Central Basin are the possibility of fault traps or stratigraphic traps where the sandstones terminate against the limits of the basin, as well as structural traps within the basin itself. An immediate objective is to find the up-dip termination of the 600 feet of porous sandstone found in American Leduc's Echevarría 8, since these sandstones are missing in all the adjacent holes.

Acreage Situation. Almost the entire basin acreage is held by the various companies comprising the Cuban Venezuelan Oil Voting Trust (CVOVT). However, Trans-Cuba, a company organized by Cuban interests, is spending $3 million to earn an undivided half interest in all of CVOVT's acreage, and the two companies together have made farm-outs in this basin, as well as in other areas.

Most of the concessions in the Central Basin were farmed out to the Cuban American Drilling and Exploration Company (Grady Vaughn, Tevis Morrow, Herb Klein et al). This company announced its intention of resuming drilling operations some time in October, probably in the tongue of the basin.

Cuban American drilled a 5000-foot dry hole at Arroyo Blanco, eight miles northeast of the town of Jatibonico, in 1954, on the initial farm-

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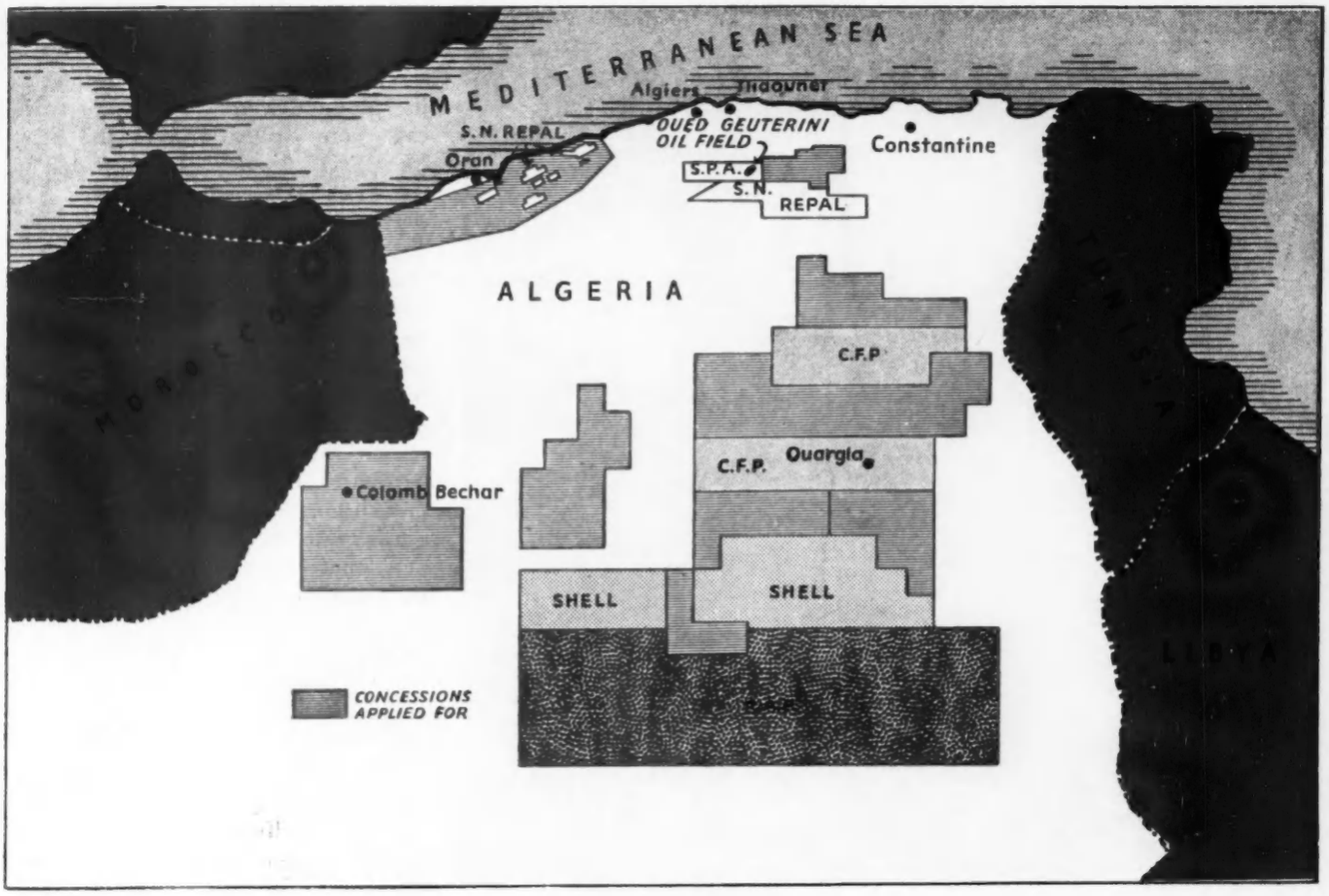


Concessions map of Algeria.

Oued Gueterini field declining, but . . .

Exploration Prospects Bright in Algeria

By MAURICE MOYAL, London

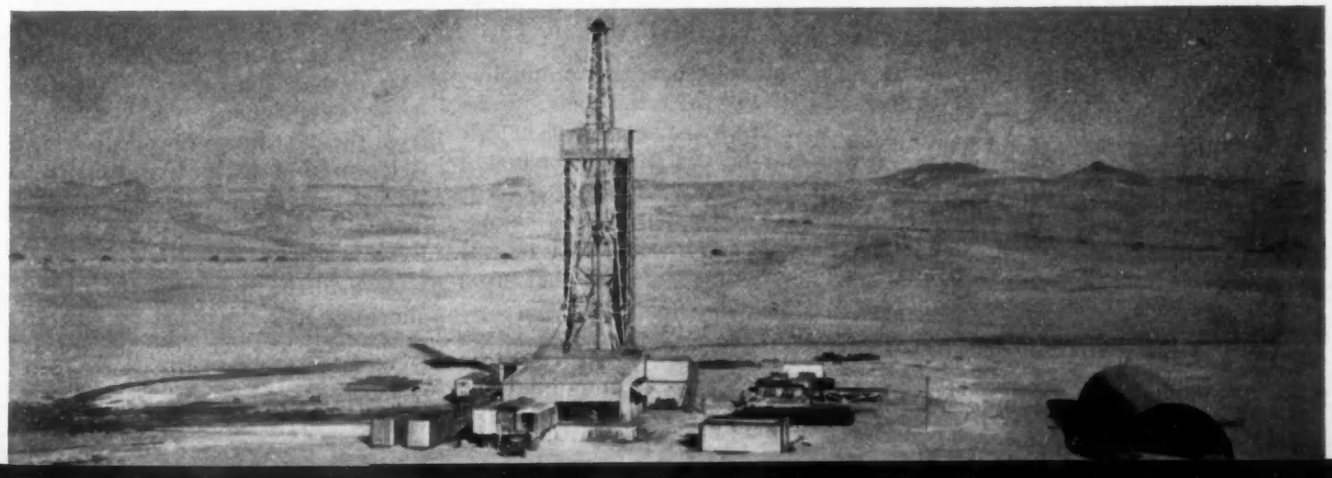
FOR A LONG time geologists have said that great oil wealth may lie beneath Algeria's 900,000 square miles—most of it uninhabited desert country.

In the Lower Chélif basin, east of Algiers, oil seepages have been known to exist ever since Roman times.

As early as 1890, exploratory drilling uncovered a few shallow deposits at Tliaounet. Nevertheless, it was not until 1946 that a methodical mapping of the country's possible oil deposits got under way. It was then that the French Government and the General Government of Algeria set up jointly the Société Nationale de Recherche et d'Exploitation des Pétroles, known as the S. N. Repal.

Areas for exploration. Surface and

Rig operating at Berriane, in Algeria's vast Sahara desert.



This rig is in the Oued Gueterini oil field.

sub-surface geophysical surveys carried out by S. N. Repal have shown the following areas in northern Algeria to be worthy of exploratory drilling:

1. The Mio-Pliocene basins of the Chélif and Mitidja, in the immediate neighborhood of the Mediterranean seaboard.

2. The Eocene basin of the Hodna, a little more to the south.

3. The northern edges of the High Plateaux.

4. The south Tell region.

5. The region east of Constantine.

Furthermore, air-surveys and seismic reflection surveys carried out by S. N. Repal and three other companies have proved as worthy of intensive exploration the following desert regions:

1. The Great Western Erg, a chain of high sand dunes in central Sahara.

2. The Colomb-Bechar basin, about 300 miles south of the seaboard.

3. The Tindouf basin, along the Moroccoan border.

4. The crystalline Hoggar range of mountains, in extreme southern Algeria.

Oued Gueterini Field. Currently the only commercially productive area in Algeria is the Oued Geuterini field, situated roughly half-way between Algiers and Constantine. S. N. Repal, operating for Société des Pétroles d'Aumale (holder of the concession covering the south Tell region) completed the discovery well in 1949. This well proved productive from the Miocene structure at a shallow depth.

Up to 1950, 50 extension and exploration wells had been drilled to establish definite boundaries of the productive area, most of it being hidden under discordant masses. More deep drillings and seismic reflection reconnaissance carried out in 1953 and 1954 quashed prospects of development in westerly and southerly directions.

Twenty wells now are productive in the Oued Gueterini field. Some are still flowing. The control of salt water may prove a major problem.

This field showed the first signs of depletion in 1954 with production decreasing from just under 1800 barrels a day in 1953 to a trifle over 1500 barrels per day in 1954. However, certain producers in the center of the field experienced no decrease in output.

To determine possible extensions to the productive area a series of wildcats were drilled around the field. MA 2, DF 1 and 2 were located to the west; DJ 1 to the north; NC 1 to the south; RL 1 to the east. The latter wildcat showed the most encouraging results, encountering in the autochthonous Miocene, hitherto found here only under marly facies, favorable sandstone reservoirs which have yielded promising oil and gas show. Furthermore, following detailed seismic refraction work, several likely structures have been found in the autochthonous Miocene, and these are being currently explored.

Annual crude oil production from the Oued Gueterini field:

Year	Barrels Daily
1951	140
1952	950
1953	1720
1954	1586

The local crude is high grade and light. It has a specific gravity of 0.830 and low in sulfur—the bane of certain Middle Eastern crudes. It is moved by tankers for refining at the Shell-owned refineries, on the shores of the sea-linked Lake of Berre—in the Greater Marseilles area. By weight it yields 34 percent gasoline, 32 percent fuel oil, 24 percent gas oil, 8 percent lube oil and only 1 percent paraffin.

Exploration by S. N. Repal. In the Chélif Basin, S. N. Repal is engaged in exploratory drilling to determine whether the oil which is already known to exist in the Upper Miocene structures of the Tliaounet reservoir is there in commercial volume. Two tests logged oil-shows in the Lower Miocene and Oligocene horizons. A heavy-duty rig is being kept busy in this area, but a well at El Abiod, near Rabelais, proved to be a dry hole at 13,330 feet.

In the Hodna basin, another dry hole occurred on the north monoclinal in the Ksob area. The monoclinal is being explored more to the west, in the neighborhood of Dokkara. A first test having struck some oil from the calcareous Eocene, a second well was sunk in its vicinity with as yet unreported results, while the monoclinal was spudded on a third location, east of Ksob.

At Selmane, in the same basin, an allochton unit, included in Miocene formations, was checked, but without

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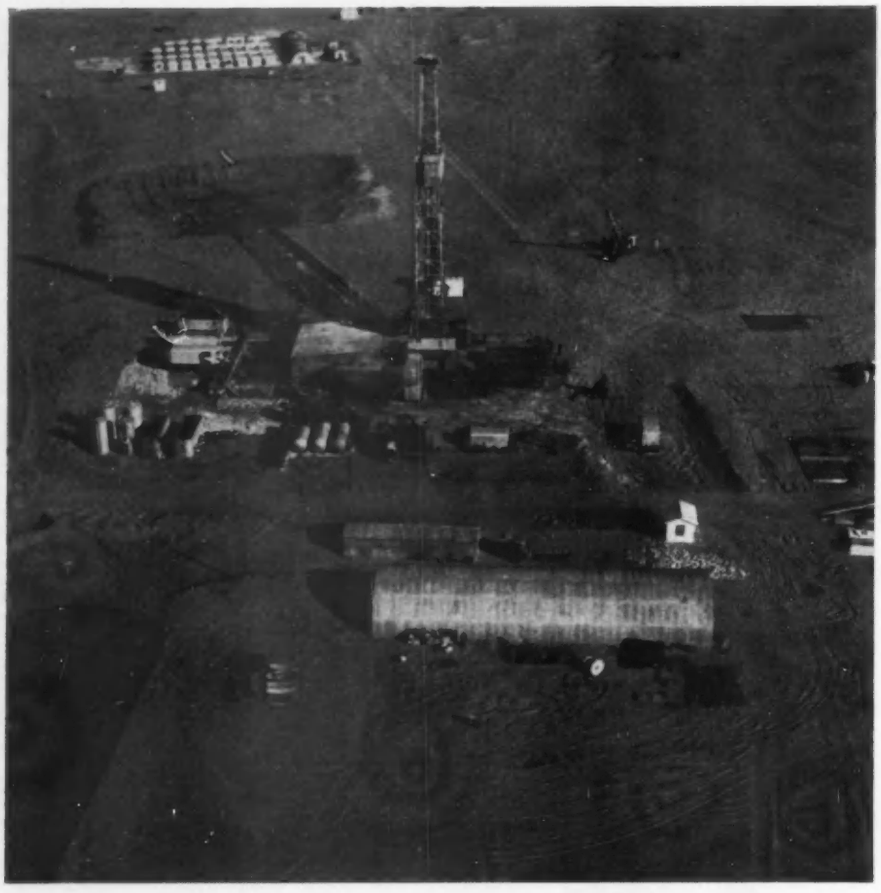

This rig is drilling in Algeria's Oued Rharbi.

encountering any calcareous Eocene. A light-duty rig is kept busy in this area, to check possible extensions of the Yprexsian levels in a southerly direction, between the north edges of the basin and a more southerly zone, where a previous drilling at Chott-el-Hammam uncovered the lack of continuity in the oil-bearing Eocene horizons.

In the region east of Constantine, at some 80 miles south of the Mediterranean seaboard, an exploratory test drilled on the Guelb anticlinal was stopped at 13,000 feet in the Hauterivian, without encountering oil. It had penetrated a series of formations dense in structure, uncovering the presence of gas in the Vraconian only.

In some sedimentary areas of the Sahara Desert itself (covering an estimated 800,000 square miles of sedimentary terrains) previous exploratory work having located the presence of limestone horizons favorable for the accumulation of oil, six wildcats were spudded in 1953 and 1954.

In September, 1954, an exploratory test drilled by S. N. Repal found at 3000 feet a natural gas deposit on the Djebel Fous, 30 miles south of Tebessa.

Other Companies' Activities. Besides S. N. Repal, the other companies engaged in aerial magnometer and gravimeter work followed by seismic surveys and wildcat drilling, are the government-controlled Compagnie Francaise des Pétroles, known as the CFP; the Compagnie Francaise des Pétroles d'Algérie, known as the CPA (a joint enterprise of the French government and of the Shell Company, which owns a majority interest); and the Compagnie de Recherches et d'Exploitation des Pétroles au Sahara, known as the CREPS, a similar enterprise, where Shell owns a minority interest.

The prospecting licenses of the four companies cover a total of 240,000 square miles, stretching all the way from the High Plateaux in the north to the lofty Hoggar mountains in the deep south, in Central Sahara. No detail maps of this area had been drawn before.

Confronted with climatic and technical problems, one geophysical, five gravimetric and seven seismic crews are gathering every type of surface and sub-surface indication. Their job is to define the general structure of these most forbidding stretches of windblown sand, strewn with residual gravel, which lie on calcareous limestones of Eocene and Cretaceous ages, with a pre-Cambrian substratum.

As such, vast desert stretches do not lend themselves readily to a quick reconnaissance by these crews. An aerial magnometer survey, taking in 40,000 square miles of the south Sahara was conducted by a French subsidiary of the American Air Service Company.

While the Shell Company is partly financing the costly exploration work in the Central Sahara, California Texas Oil Company has sent in a mission on a preliminary geological reconnaissance of the east part of the Tindouf basin, curving along the Moroccoan border in the west Sahara. The other sections of this potentially oil-rich sedimentary basin are being studied by Morocco's Société Chérifienne des Pétroles and the S. N. Repal.

In the neighborhood of the Moroccoan border, the sedimentary Colomb-Béchar basin, about 350 miles south of the Mediterranean seaboard, came in for a pilot test on the Taoudrara

About the Author

MAURICE MOYAL is a French-born journalist who attended the Paris Sorbonne University and received a Ph.D. summa cum laude. During World War II he was a captain in the Free French Commandos and saw action in North Africa. He is a prolific writer having contributed to such publications as the *National Geographic Magazine, Reader's Digest, Iron Age, Light Metal Age, Barron's, Washington Post, New York Times,* etc.

Kahla structure. But after penetrating a shallow Devonian and Gothlandian, S. N. Repal stopped the drilling in the Ordovician quartzites. The facies did not prove favorable and no oil-shows were found. Nevertheless, geological and gravimetric data are still being sought on these promising 3000-foot thick marine sediments, although reflection seismic work yielded but poor results there.

Major Concessions. Together with the CFP, S. N. Repal has assembled a block of concessions covering 110,000 square miles which includes the whole width of the north Sahara, from Colomb-Béchar on the Moroccoan border to Touggourt near the Tunisian border. Thanks to considerable exploratory work on the edges of the Great Western Erg, a likely drilling location was pinpointed at Berriane, in the neighborhood of the oasis of Ghardaia, lying a few miles northwest of the geographical center of the Sahara.

The wildcat here penetrated the Jurassic, then the salt-bearing Trias, to uncover a gas find and promising oil-shows in the underlying residual series, of unidentified age, to stop at 9148 feet in the pre-Cambrian substratum. It was the very first time that a positive proof of the presence of oil was uncovered in those vast stretches, where oilbearing structures have no surface expression. Further drillings in the residual series recovered only salt water, but at such high pressure and volume as to amplify the previous seismic reconnaissance at Tilrhemt, situated northwest of Berriane.

Latest reports show that S. N. Repal is spudding its third wildcat on the Oued Rharbi structure, roughly midway betwen the Colomb-Béchar basin and the Berriane structure.

Having purchased in the U. S. a heavy-duty rig, the CFP has started core-holes for geological information on the southern flank of the Great Western Erg, in the El Golea region, some 250 miles due south of Berriane. This venture is now mainly engaged in seismic reconnaissance.

CPA, a Shell subsidiary, has secured a 100,000-mile prospecting license, in between the Great Western Erg and the Great Eastern Erg, to the south of the CFP and S. N. Repal concessions. In 1954, it stepped up exploratory work, putting in the field three gravimetric and two seismic crews. A medium rig is spudding the first wildcat on the primary Timimoun structure.

Still to the south of the CPA permit area, CREPS has secured a prospecting license covering 80,000 square miles from the Adrar Range to the borders of Tripolitania. It has concentrated its main exploration effort on the Ahnet basin, which has a number of anticlinals.

A wildcat was located, following detailed seismic work, on the Djebel Bergha, in the Adrar Range. After blocking out a natural gas deposit, it struck oil from a porous limestone reservoir in the Upper Devonian. It is inconceivable that this well, situated 40 miles southwest of In-Salah, was an isolated discovery, because the horizons in which the oil was found are known to exist over a wide area in deep south Sahara.

It would be rash to predict that the fabulous oil wealth lies buried under the sands of the Sahara. Yet, some of the favorable factors controlling the accumulation of oil are present there: thousand-feet thick sediments, good reservoir rock conditions, large anticlinals, and good covering rocks to prevent the escape of oil to the surface. The over-riding initial richness of rock sources remains largely an unknown quantity. On the whole the outlook is optimistic.

ACKNOWLEDGMENT

This article released to WORLD OIL through the courtesy of *Oil*, the journal of the M.O.R. group of companies, London, England.

—**The End**

Cuban Test Proves Up Basin

Continued from Page 262

out. Since then, it has been conducting seismic work in the area and recently exercised an option to acquire additional acreage, making its total holdings 1,026,000 acres (see map No. 2). Cuban American must drill 35,000 feet of exploratory hole to earn a half interest in these concessions, after which the cost of exploration work will be shared with CVOVT and Trans-Cuba.

Standard Oil Company of Indiana recently acquired a farm-out from CVOVT and Trans-Cuba on over 11 million acres (see map No. 2) of which a large portion covers what may be a southward extension of the basin on the shallow water shelf, south of the cuban American farm-out. Stanolind is committed to spend $2 million a year in exploration for five years or drill 40,000 feet of hole a year, and can only withdraw by paying a $1 million forfeit. Company officials have announced an immediate program of seismic and geological work, and may start drilling the first year.

Trans-Cuba has retained about 45,000 acres in the known basin area, as part of the concessions to be drilled to earn its one-half undivided interest with CVOVT. Sancti Spiritus 1 was drilled on this block of concessions, and a second 10,000-foot test, Sancti Spiritus 2, was under way.

Apart from CVOVT farm-outs, other companies have smaller holdings in the basin. Cuban Oil Corporation (Pacific Petroleum et al) acquired 11,000 acres on a farm-out from Lincoln G. Valentine and has additional acreage in the shelf area. This latter block is part of over 3.5 million acres held by the Perla Negra group of companies controlled by William B. Duce, California attorney, and Lincoln G. Valentine. Cuban Oil Corporation acquired an option to select 75 percent of this acreage for active exploration, Perla Negra retaining 25 percent for development or farm-outs.

Cuban Colombian also has approximately 28,000 acres in the basin. This company and Cuban Oil Corporation unitized a small group of leases for the drilling of Norita 1, the 4500-foot test four miles west of the town of Jatibonico, which is to be deepened.

The Central Basin is by far the best oil prospecting area so far known in Cuba. All companies having acreage there are planning active seismic programs.

Seismic work already completed has yielded excellent records and indicates gentle dips with convergences of horizons ideal for stratigraphic traps. It is also reported that anticlinal structures with several hundred feet of closure have been found. These structural situations, combined with the known presence of porous sand bodies, add up to a most promising oil prospect, which may result in Cuba taking its place among the important petroleum producing countries of the world. —**The End**

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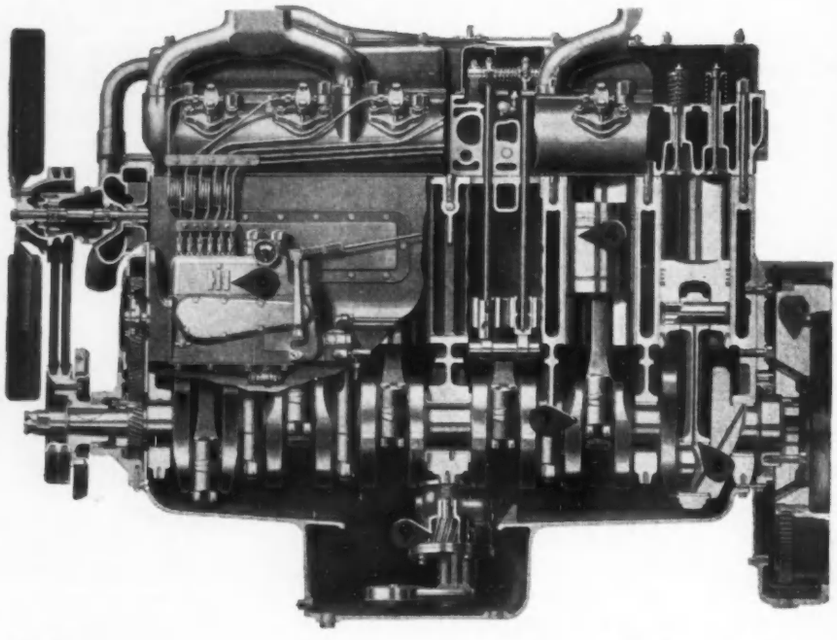

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AMONG WORLD OIL MEN

Rufus T. Burton

James D. Jacobs

Gerald L. McCoy

Joseph A. Parrish

A new administrative setup for the coordination at New York of Standard-Vacuum Oil Company operations in the Eastern Hemisphere has been announced. The change provides for five regional coordinators in charge of all phases of Stanvac's integrated oil operations within their respective geographical regions.

The coordinators will report directly to the Stanvac board, and will work closely with the overseas managers who carry on-the-ground responsibility for the various operations such as exploration, producing, transportation, refining and marketing.

The coordinators are:

RUFUS T. BURTON, regional coordinator for Stanvac's South Asia and East Africa regions, including India, Pakistan, Ceylon, Burma, East African countries from Tanganyika to the Red Sea, and Madagascar. Burton's most recent assignment was as general manager at Bombay for the company's marketing operations in India and adjoining countries.

JAMES D. JACOBS, regional coordinator for Australia, New Zealand and the Pacific Islands. Jacobs served formerly as managing director of two of Stanvac's subsidiary companies in Australia. He will act temporarily as coordinator for the Southern Africa region, including the Union of South Africa, the Rhodesias and Portuguese East Africa (Mozambique).

GERARD L. McCOY, regional coordinator for Southeast Asia, including Indonesia, Malaya, Thailand, and Indo-China. Until recently McCoy served as general representative in Indonesia.

JOSEPH A. PARRISH, regional coordinator for the Far East region, including the Philippines, Japan, Korea, Formosa, and the Colony of Hong Kong. Formerly, Parish was general manager of marketing in the Philippines.

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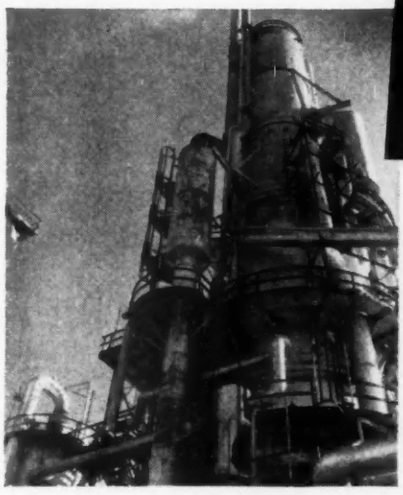

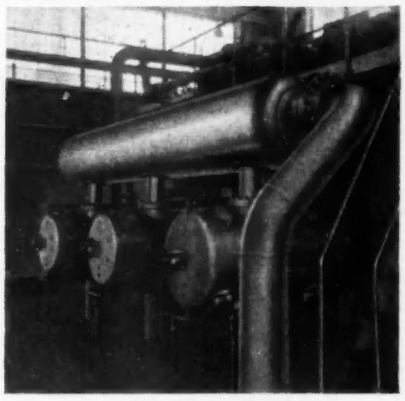

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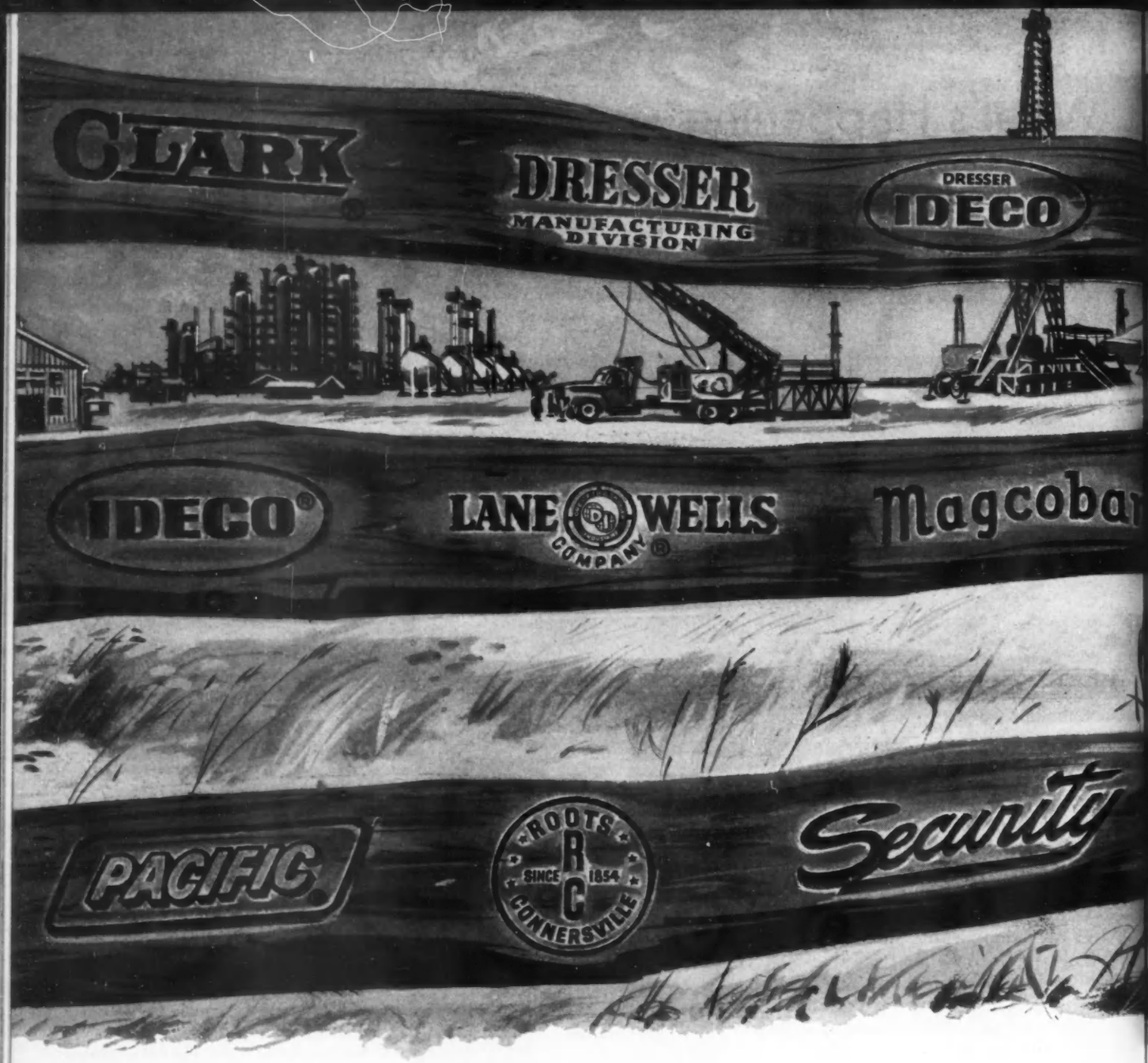

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TOM WILSON, division safety supervisor, Socony Mobil Oil Company, and his family returned to Venezuela in September after a vacation in the U.S. While in the U.S. Wilson enrolled a daughter, Ruth Lyn, in St. Stephens Episcopal School at Austin, Texas. Two other daughters, Sarah and Janet, returned with Mr. and Mrs. Wilson to their home at Socony's Anaco camp.

•

G. R. WALKER has been appointed treasurer of International Petroleum Company, Limited. Born in New York, Walker was graduated from Yale University in 1944 with a B.A. degree and from Harvard University's Graduate School of Business Administration with an M.B.A. degree in 1948. In that year he joined Standard Oil Company (New Jersey) in the Treasurer's department and in 1951 went to International Petroleum as assistant treasurer.

•

CHARLES D. McKENZIE has been appointed administrator of petroleum statistics with the Petroleum and Natural Gas branch of the Saskatchewan Department of Mineral Resources, succeeding James W. MacNeill, who resigned to return to the University of Saskatchewan to further his studies in engineering and business administration.

McKenzie previously worked for McColl-Frontenac Oil Company Limited in Calgary, Alberta, and Saskatoon, Saskatchewan.

•

GAVIN WITHERSPOON, formerly vice president of Bahrain Petroleum Company, now is vice president and general manager of American Independent Oil Company, with his headquarters in Kuwait. Witherspoon succeeds JAMES MacPHERSON, who retired after six years with Aminoil to assume his post as petroleum advisor to the Saudi Arabian government.

Witherspoon has had extensive experience both in the U.S. and in the Middle East in operational aspects of the oil business and in intergovernmental relations. One of the first engineers to go to Saudi Arabia for the Arabian American Oil Company in 1936, he has since spent many years both in Saudi Arabia and on Bahrain Island.

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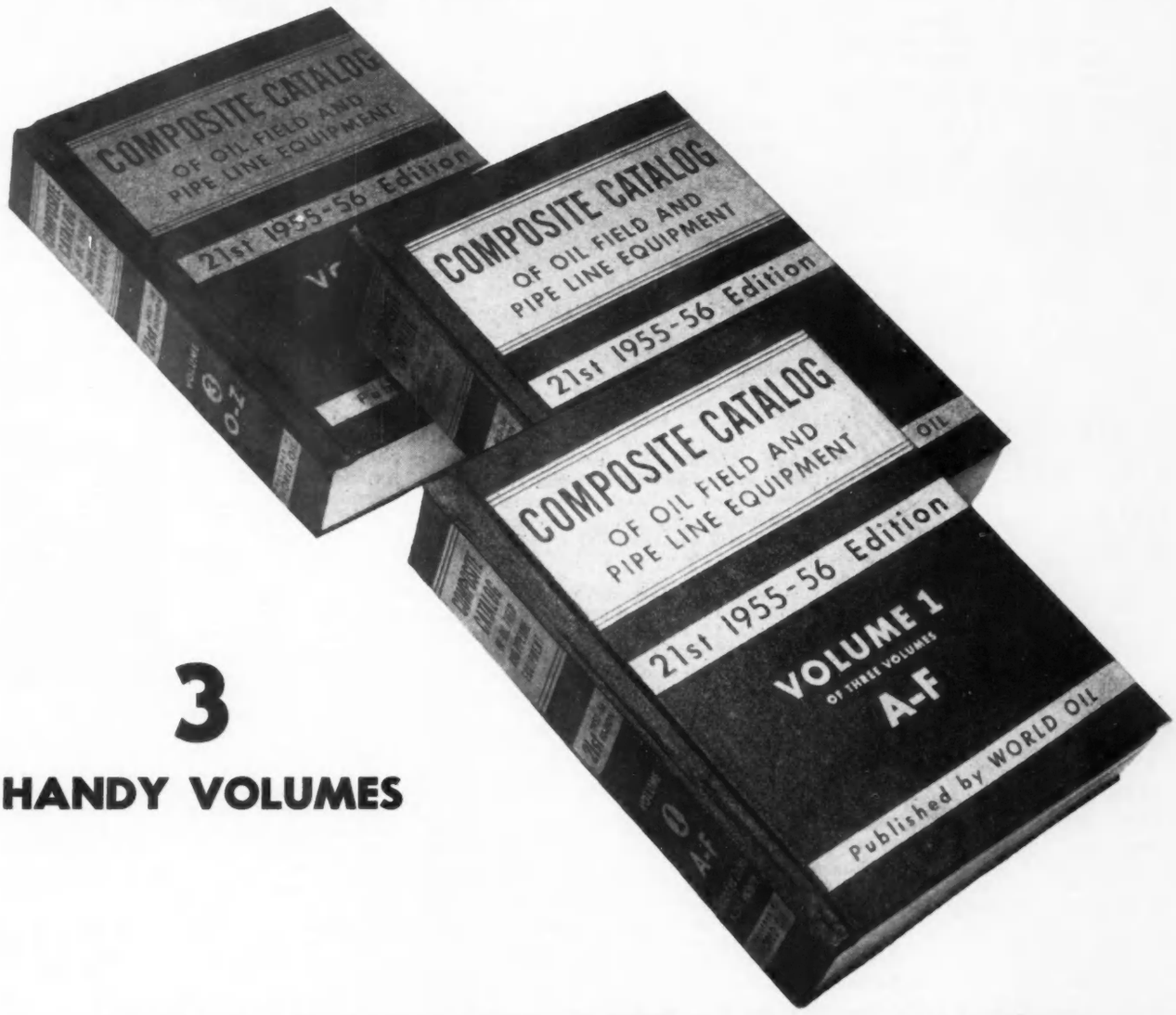

3

HANDY VOLUMES

THE COMPOSITE CATALOG

PUBLISHED BY WORLD OIL

What's Happening

AMONG MEN IN THE INDUSTRY

John L. Creigh

Forrest J. Allen

Delta Gulf Drilling Company has announced the affiliation of **John L. Creigh** as drilling engineer and assistant to the division manager of its West Texas division with headquarters in Odessa; and **Forrest J. (Chuck) Allen, Jr.**, as drilling engineer for its Gulf Coast division, with operating offices at Houston and Lake Charles, La. Creigh previously has been with Humble Oil & Refining Company and Reynolds Mining Company. Immediately prior to joining Delta Gulf, he was in private consulting business in Durango, Colo. Allen, before joining Delta Gulf, was with The California Company in southern Louisiana and was production superintendent for Concho Petroleum Company in Dallas.

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Francis E. McNeil recently joined **Calvert Drilling, Inc.**, as administrative assistant to the president. He formerly was with Arrow Drilling Company as office manager. He will be located in Calvert's home office at Olney, Ill.

•

Carter Oil Company Production department personnel changes recently announced include **Paul E. Schauer** who will head the company's reservoir engineering effort throughout the territory in which Carter operates. He will headquarter in Tulsa. Schauer has been with the company since 1948. **Milton E. Fox**, recently transferred from the petroleum engineering section to become district engineer at Purcell, Okla., replaces **Reginald D. Orr** who has been named staff engineer at Carter's Southern division office in Shreveport. **George H. Link**, assistant superintendent of the Carmi district, will replace Schauer at Mattoon, Ill., as staff engineer, and **John L. Dailey**, Carmi district engineer, will become assistant district superintendent there. **Jack K. Lytle** transfers to Carmi as district engineer, and **Kenneth H. Larsen** will replace Fox in the petroleum engineering section.

•

Thomas P. Pike Drilling Company announces that **Dan Duncan** has been employed as assistant to the drilling superintendent. He joined the firm after many years in the drilling and drilling machinery manufacturing business.

•

A. L. Thomas has joined the Midland office of **Southern Geophysical Company** as party chief. Thomas' 15 years in geophysical prospecting includes service as party chief with Stanolind Oil & Gas Company.

•

Standard Oil Company of California announces the appointment of **T. L. Lenzen** and **G. L. Parkhurst** to the company's board of directors. Lenzen, prior to his appointment as a vice president of the company in 1952, had been manager of Standard's Eastern Hemisphere operations. He is a director of the Bahrain-Caltex Group of Companies, an affiliate of Standard. Lenzen joined the company in 1928. Parkhurst, a vice president since 1949, previously was president of Oronite Chemical Company, chemical marketing subsidiary. A director of Arabian American Oil Company and Trans-Arabian Pipe Line Company, he joined Oronite in 1946. **J. P. Bowman**, recently appointed assistant secretary of the company, joined Standard in 1936. He formerly was a legal representative in the Marine department.

•

Davis Bros. Exploration Consultants announced the affiliation of **Ralph A. Hockenson** with their organization, and the appointment of **Richard E. Price** as manager of exploration. Hockenson will be in charge of secondary recovery and evaluations for the company. He formerly was with the Bureau of Mines experimental station at Bartlesville, Okla., Ohio Oil Company and Carter Oil Company. Price has served with Davis Bros. for the past five years as geologist.

Edmund C. McCallum has retired as leasehold and division order supervisor for **Stanolind Oil and Gas Company's** North Texas-New Mexico division at Fort Worth, after nearly 26 years of service with the firm. He is now with Lyons, McCord and Logan, independent oil operators in Shreveport. His association with the Stanolind group began in 1929 when he joined the Dixie Oil Company, a predecessor of Stanolind. Prior to that he had been in the legal department of Standard Oil Company of Louisiana. Under Stanolind's decentralization program, McCallum was transferred to Fort Worth in 1953.

E. C. McCallum

•

Hugoton Plains Gas and Oil Company has announced the election of **H. R. Bolton** as president and **N. K. Anderson** as vice president. Bolton is vice president, exploration and production, of Crescent Corporation. Anderson is director of research and development for Crescent and will supervise sales for Hugoton. Other officers of Hugoton are **W. F. Styler, Jr.**, vice president and treasurer, and **O. O. Kerr**, secretary.

•

Standard Oil Company of Texas recently announced the following personnel changes: **Ralph G. McIntyre**, director and president of the company for the past nine years, has been elected chairman of the board. This position formerly was held by **Gage Lund**, vice president of Standard Oil Company of California. McIntyre joined Standard of California in 1910 and is now completing his 45th year with the company and its subsidiaries. **K. H. Shaffer** was elected a director and president of Standard of Texas succeeding McIntyre. Shaffer joined Standard of California as an engineer doing survey work on new concessions in Venezuela. For the past three years he has been director, vice president and assistant to the president of The California Company, a subsidiary of Standard of California in New Orleans. **John Domercq, Jr.**, who has been a vice president and director of Standard Oil Company of Texas for six years, headquartered at Houston, has resigned to become a director, vice president and assistant to the president of The California Company.

•

Andrew T. Sweet, mining and metallurgical engineer, is a new member of the board of directors of **Overland Oil, Inc.**, of Denver. Sweet resigned from the U. S. Bureau of Mines early this year to become a consultant to Overland on uranium milling and mining and to establish his own Sweet's Engineering Laboratories in Denver. As a director, he will assist Overland President E. F. Schmidt in development of the process and the uranium leases.

W. L. Peyton has been promoted to assistant to the manager of **Continental Oil Company's** headquarters geological section in Houston. **E. F. Culp,** staff geologist for Conoco, succeeds him as Oklahoma City division geologist. Peyton joined Conoco in 1948 and was promoted to division geologist in 1951. Culp has been with the company at Oklahoma City since 1953.

•

J. W. Fishback, district geophysicist for **Stanolind Oil and Gas Company,** recently was transferred from Roswell to the Stanolind district exploration office in Albuquerque. With the company since 1936, Fishback has been assistant party chief, party chief, gravity meter supervisor and field seismograph supervisor. He was named district geophysicist at Roswell this year.

•

H. D. Fox, now serving in **Sohio's** Regina district office as chief geologist, Canada, will be transferred to Oklahoma City as district geologist for Oklahoma. He replaces **L. H. Rogers** who will be transferred to New Orleans as staff geologist to aid in offshore work. **Thomas A. Parks,** now senior geologist in Sohio's Regina district office, will be promoted to district geologist for Regina.

•

Neville G. Penrose, Inc. announces the election of **John P. McNaughton** to vice president. With the company as assistant vice president since 1953, McNaughton previously was an engineer with Gulf Oil Company.

•

Charles A. (Buck) Rowe, veteran flyer and aviation representative for **Gulf Oil Corporation,** recently was appointed to the Texas Aeronautical Commission. This commission is a three-man body appointed by Governor Allan Shivers to advise him and the legislature on aviation matters. Rowe started his career as a flyer in 1917 in the U.S. Navy. He flew airline and charter service in the West Indies prior to his appointment by the U.S. Department of Commerce as supervisor of Aeronautical Inspection in charge of Texas, Oklahoma, Arkansas, Louisiana, New Mexico, Arizona and southern California. He has been in charge of the Aviation department and Aviation sales for Gulf in the Southwest 17 years.

C. A. (Buck) Rowe

•

W. Bruce Lerch, recently appointed technical consultant for **Drilling Specialties Company,** a subsidiary of Phillips Petroleum Company, will work primarily in further technical development and sales engineering of the Diacel system for well cementing. In addition, he will perform work relating to the company's Driscose drilling mud additive. Lerch has been with Phillips 33 years and was the first chemist employed in the Production department. He served as chief chemist many years, becoming, during World War II, associate director of research. He was later engaged in industrial sales engineering work in the Sales department.

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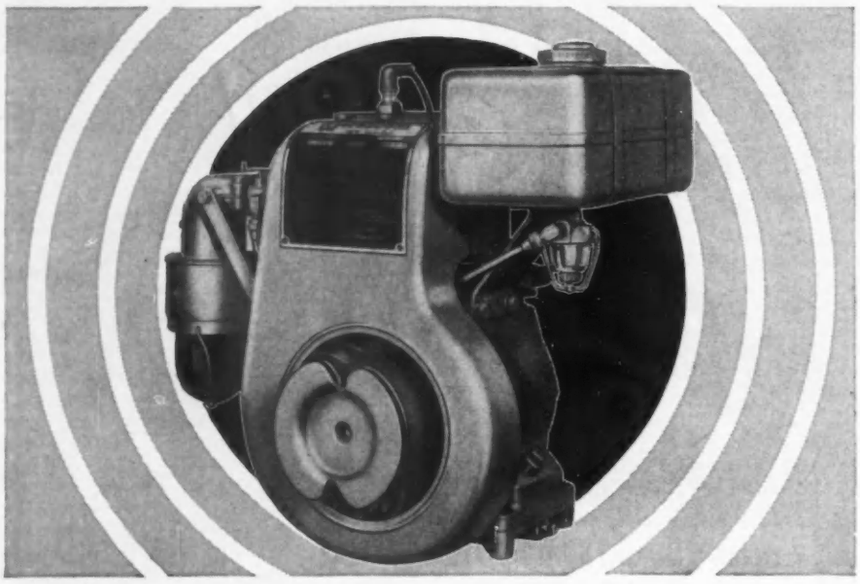
(For more data on advertised products, use Readers' Service blue cards, last page this issue.)

Dallas R. Lamont has been elected to the board of directors of **Socony Mobil Oil Company, Inc.** Patent counsel since 1931, he will be in charge of the research and development program and of the company's laboratories. **William M. Holaday,** who has headed Socony Mobil's research and development activities since 1944, has been named to a new position as coordinator, new product planning. He will coordinate the company's forward planning of product quality and will serve as chairman of an interdepartmental committee to be established. Holaday joined Socony Mobil in 1937 as assistant general manager of the company's laboratories. He previously had been a research engineer with the Standard Oil Company of Indiana.

Percy M. Lyons has joined the **P. R. Rutherford** organization in Houston as district geologist for south Louisiana. He formerly was assistant division geologist for Sinclair Oil & Gas Company, Gulf Coast division.

•

Nash J. Dowdle recently announced the formation of the **Texas American Oil Corporation** of which he is president. The new firm plans to engage in drilling and exploration in the West Texas and southwestern New Mexico area. On the board of directors are **C. L. Milburn,** executive vice president; **J. H. Bartley,** vice president; **D. C. Baldwin,** secretary-treasurer; **Thomas F. O'Neil; Peter M. Kelliher** and **John J. Dowdle III.**



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Robert O. Garrett, a veteran of nearly 30 years in the oil and gas production field, has been appointed vice president and general manager of **Texas Gas Exploration Corporation,** the production subsidiary of Texas Gas Transmission Corporation. Garrett has been manager of the exploration and production engineering departments of Arkansas Louisiana Gas Company since 1953. He joined Arkansas Fuel Oil Company and a predecessor of the natural gas company in 1926.

Robert O. Garrett

•

J. H. (Jack) Berry, who organized Continental Supply Company's Canadian branch in 1949, has been elected president of **Devon Drilling Company Limited,** an Alberta contracting firm which he joined two years ago as managing director. Also elected to the directorate were **W. L. Falconer,** executive vice president of Amurex Oil Company, and **Vernon Van Sant,** Amurex controller. Except for 4½ years in the contracting business, Berry was associated with Continental Supply in various U. S. and Canadian oil fields until he joined Devon Drilling.

•

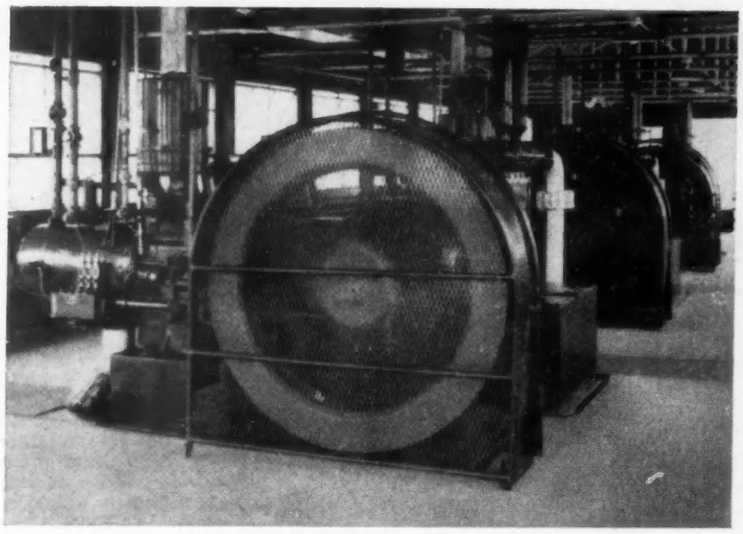
John W. Sutton has been appointed Oklahoma division production manager for **Shell Oil Company,** succeeding **J. F. Redmond** who was recently transferred to the head office in New York. Sutton first joined Shell in 1937 as a district superintendent in Iowa, La. In 1946 he moved to the Houston office where he subsequently served as an administrative assistant and then personnel and industrial relations manager. In 1949 he was named Kansas division production manager, a position he has occupied until his recent transfer to Oklahoma City. Other personnel changes in the company's Tulsa area production department include: **R. E. Clark** promoted from Illinois division exploitation engineer to Kansas division production manager; **B. V. Barker** transferred from Kansas division production superintendent to Illinois division production superintendent; **R. F. Wicks** promoted from Ardmore district production superintendent to Kansas division production superintendent; **E. A. Milz** promoted from exploitation engineer to Illinois division exploitation engineer; and **F. C. Buckwalter** promoted from a special assignment to Ardmore district production superintendent.

•

Walter M. Wilkinson recently opened independent petroleum consulting offices in Midland. He formerly was vice president and manager of land and exploration for the Oil division of Hanley Company.

•

Walter H. Helmrich, president, **White Eagle Oil Company,** has been presented the bronze "Oscar of Industry" for the best annual report of the small petroleum companies. White Eagle was judged winner in the fifteenth annual survey by the "Financial World." The presentation was made by Weston Smith at a banquet in New York City.



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Floyd S. Bryant, recently appointed special assistant to the Secretary of Defense, retired from **Standard Oil Company of California** as a vice president and director, after a career of nearly 34 years. Bryant joined the company's Producing department in 1922. Assignments of increasing importance led to his appointment as manager of exploration in 1936, general manager of the department and director of the company in 1940, and a vice president in 1942.

Floyd S. Bryant

•

Humble Oil & Refining Company recently announced the following changes in Production department supervisory personnel: **R. M. Lilly,** assistant district superintendent, Hobbs district, West Texas division, was promoted to district superintendent of the new Farmington district in New Mexico; **J. C. Wisely,** assistant district chief clerk at Wasson, was promoted to district chief clerk at Farmington; **V. J. Fletcher,** farm boss at Wasson district, West Texas division, was promoted to assistant district superintendent; **J. M. Diamond,** mechanical supervisor, Mallalieu district, Louisiana division, was promoted to farm boss at Mallalieu; and **H. T. Mitchell,** gas plant repairman, Opelousas Gas Plant, replaced Diamond as mechanical supervisor. **J. D. Moore,** district petroleum engineer, Vernon district, North Texas division, transferred to the Petroleum Engineering division, Houston, as senior petroleum engineer; **J. D. Thompson,** roustabout gangpusher, Lovell Lake district, was promoted to farm boss; **Narvin B. Frickman,** senior petroleum engineer, North Texas division office, was transferred to the Bakersville district, California Area as district petroleum engineer; and **Gordon T. Rees,** assistant chief special officer, was promoted to chief special officer, replacing J. A. Honea, retired, Houston office. **J. R. Montgomery,** senior civil engineer, East Texas division officer, was promoted to supervising civil engineer.

•

H. H. Charles of **Phillips Petroleum Company's** land and geological department has been appointed technical assistant to the department's exploration director, with **R. O. Dunbar** named to succeed him as assistant regional manager and regional geologist for the northwest region. Charles joined Phillips in 1936. Dunbar was assistant regional geologist for the northwest region until his latest appointment. He has had 13 years of geophysical and geological experience with Phillips.

•

Socony Mobil Oil Company, Inc., announces the appointment of **H. A. Metzger** as manager of the Dakotas district of its White Eagle division, succeeding the late **C. W. Shields.** The Dakotas district has headquarters in Aberdeen, S. D. **L. G. Wetzbarger** of the Iowa district has been transferred to Dakotas district and appointed assistant district manager, succeeding Metzger. **John R. Kercheis** has been appointed assistant manager of the Iowa district, succeeding Wetzbarger.

Ralph I. Ellsworth, formerly Gulf Coast division engineer with Sinclair Oil Company, has resigned to join **Rycade Oil Corporation** as drilling and production superintendent. Formerly an instructor in the Petroleum Engineering department at the University of Texas, he joined American Republics Corporation in 1949 and was chief petroleum engineer prior to joining Sinclair.

•

Howard W. Unruh, assistant secretary and assistant treasurer of **Sun Oil Company,** is retiring after 46 years of service. Unruh has been an assistant treasurer since 1928 and an assistant secretary since 1930. In retiring, he also relinquishes positions as assistant secretary and assistant treasurer of Sun Oil Company, Ltd.; Sperry-Sun Well Surveying Company, and Sperry-Sun of Canada, Ltd.; and as assistant treasurer of Crodero Mining Company, all Sun Oil subsidiaries. **Captain Robert J. Ball,** port captain for Sun Oil Company, also has retired. Joining Sun with the rating of third mate in 1916, he was given his first full command in 1920. This was the S.S. Paraguay, a Great Lakes ore carrier converted to tankship and the first ship owned by Sun Oil Company. He was made port captain at Marcus Hook, Penn., in 1948.

•

M. S. Patton, Jr., has been named manager of the Joint Operations division of **Sunray Mid-Continent Oil Company's** Production department. Previously acting manager of joint operations, he succeeds **J. R. Vandever** who was named head of the company's new Property Acquisition department. Patton joined Sunray in 1946 as district engineer, and was promoted to division engineer, division exploration engineer and then acting head of joint operations.

M. S. Patton, Jr.

•

Malcolm D. Abel has been promoted to West Texas division manager of **B B M Drilling Company.** In his new capacity, Abel will supervise rotary drilling tools and production development. Before joining B B M in 1951, he was West Texas District engineer for the Plymouth Oil Company.

•

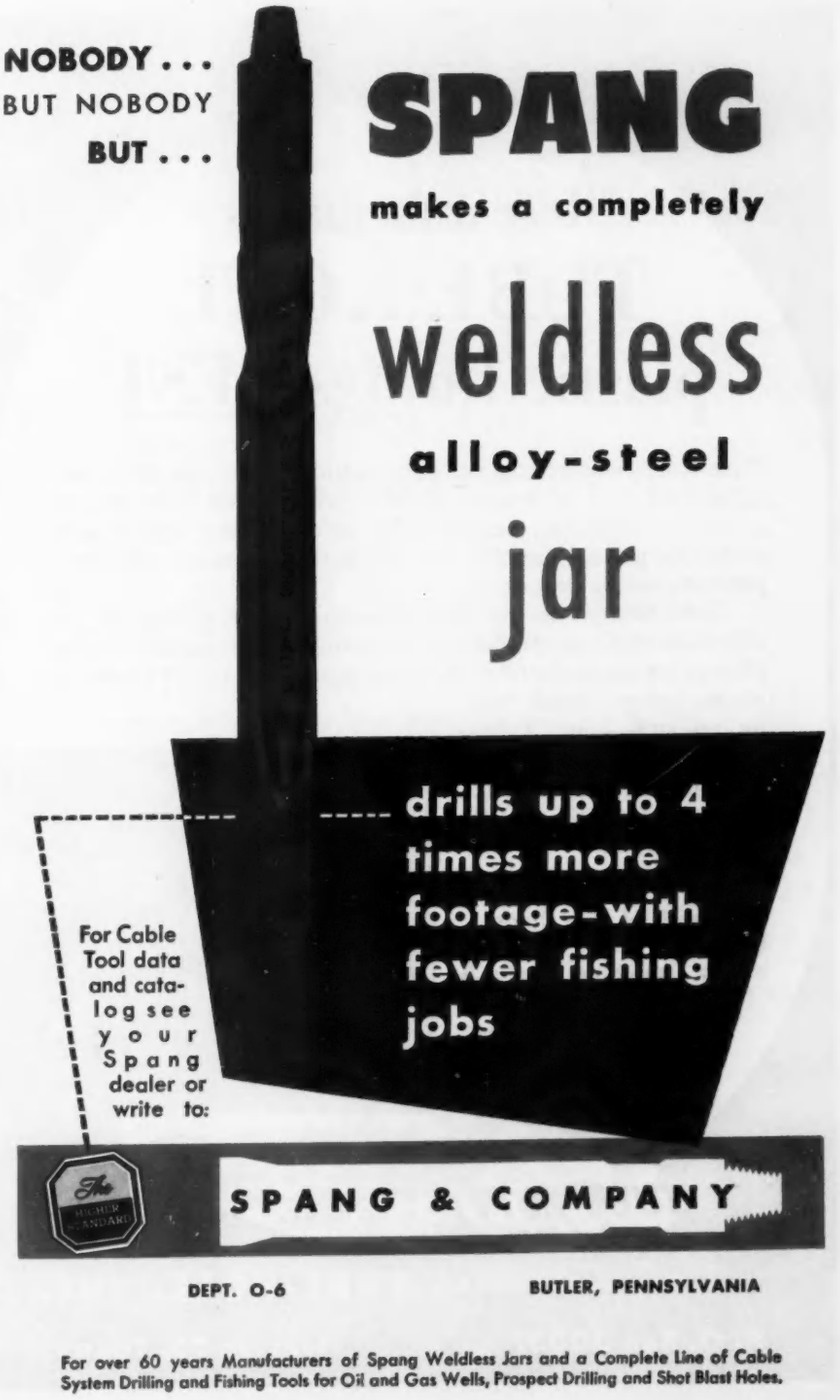
James S. Royds, recently appointed assistant manager of **Continental Oil Company's** Foreign department, with headquarters in Houston, will be associated with **S. K. Clark,** manager of the department. Since 1954 Royds has been manager of exploration for Egyptian-American Oil Company, subsidiary of Continental Oil with headquarters in Cairo. Royds joined Conoco in 1939 at Denver. He was promoted to division geologist and regional geologist successively in 1950 and served as exploration manager of Conoco's Rocky Mountain region two years before moving to Egypt in 1954.

Argo Oil Corporation announces that **B. W. Gwinn,** formerly with California Company, has accepted a position as geologist with Argo in Denver.

•

Harold D. Becwar has been made division geologist of the South Texas division, **The Texas Company's** Producing department. He joined the company as junior geologist in Corpus Christi in 1940 and was promoted to district geologist in San Antonio in 1944. He was transferred to the Houston division office in 1950 as senior geologist.

R. S. Randerson, Jr., who has been named administrative co-ordinator for the producing division of the **Tennessee Gas Transmission Company,** will be responsible for co-ordinating administrative functions of the various departments in the producing division and also will carry out administrative liaison between the producing division and other divisions of the company. Randerson had been chief production clerk since 1949. Other appointments announced include: **A. C. Edmundson,** to the post of chief production clerk; **C. A. Richardson, Jr.,** as chief exploration clerk in the Houston office; and **W. Miskimins, Jr.,** as division production clerk in the Fort Worth division office.



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(For more data on advertised products, use Readers' Service blue cards, last page this issue.)

Watson Caldwell, district geologist for **Sunray Mid-Continent Oil Company** at Lake Charles, La., has been promoted to Gulf Coast division geologist with headquarters in Tulsa. He will supervise geological operations for Sunray Mid-Continent in south and East Texas and in Louisiana. Caldwell joined the company in 1953 as district geologist in Lake Charles. Previously he was with Signal Oil and Gas Company in Houston.

Watson Caldwell

Humble Oil & Refining Company recently announced the following changes in its Production department supervisory personnel: **R. M. Hunt,** associate petroleum engineer, Goose Creek district, was named petroleum engineer, Houston Office, Petroleum Engineering division; and **E. M. Case, Jr.,** associate petroleum engineer, Southwest Texas division office, was made petroleum engineer. **L. B. McElroy,** electrician, Gladewater district, East Texas division, was named district electrical foreman of the Athens district; **D. B. Hurst,** roustabout gangpusher, Bayou Sale district, Louisiana division, was promoted to farm boss at the Grand Isle district; and **Travis W. Caldwell,** gas plant operator, Katy Gas Cycling Plant, was made head cycling plant operator. **E. G. Copley,** compressor plant foreman, Seeligson compressor plant Stratton district Southwest Texas Division, named gas plant superintendent at the Opelousas Gas Plant, was succeeded by **J. F. Carroll,** formerly head cycling plant operator at the Katy plant, Gulf Coast division. **A. H. Pickens,** toolpusher, Athens district, East Texas division, transferred to the Grand Isle district, Louisiana division, as toolpusher.

•

W. R. Davidson, petroleum geologist, has opened geological offices as an independent in Lafayette, La. He has been with Sohio Petroleum Company in the Lafayette district office for the last five years.

•

N. P. Whaley and **Alton A. Harrison** have formed the **Petroleum Investors Management Company,** with offices in the Life of America Building, Dallas, Texas.

•

A. R. Wilson, who has been in the service of **The Texas Company** more than 39 years, mostly in the management branch of production operations, retired October 1 as assistant general manager of the Producing department. His oil career spans a period of tremendous progress in techniques and methods of discovering and producing crude oil. He was the first division manager of the company's Rocky Mountain division and once served as manager, Producing department, The Texas Company Canada, Ltd., while handling other management duties in the U.S. Wilson started with The Texas Company in the Comptroller's department at Houston in 1916.

A. R. Wilson

•

Kinsey Davis, editor of the HUBER NEWS, house organ for the **Huber Corporation** of Borger, Texas, has been named editor of the year by the Society of Associated Industrial Editors. The award was made in Tulsa at the annual meeting of the SAIE.

•

Eugene E. Dawson, former head of the Drilling department of **International Petroleum Company, Limited,** has been promoted to services superintendent. He joined International in 1952 as assistant drilling superintendent. **G. V. Young,** assistant head of the drilling department, succeeds Dawson as department head. Young joined International as drilling foreman in 1948. Succeeding him is **S. D. Denney, Jr.,** former head of the drilling engineering section of the Petroleum Engineering department, now assistant head of the Drilling department. He joined International in 1954.

•

Roger W. Stoneburner recently joined the **San Jacinto Petroleum Corporation** to direct geological operations. With offices in Houston, the firm's primary area of operations is the Louisiana and Texas Gulf Coast. Stoneburner formerly was district exploration superintendent for The California Company in southeastern Louisiana.

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DEATHS

Clyde E. Galbraith, 73, pioneer drilling contractor, died November 3 at Abilene, Texas. Until his retirement in 1935, he had been active in Oklahoma and Kansas since 1904.

William Z. Dozier, 75, independent oil operator and former vice president of Gilcrease Oil Company, died October 30.

W. E. (Doc) Grisso, 81, pioneer oil man of Seminole, Okla., died October 31.

Ralph C. Warner, 89, former treasurer and member of the board of directors of Standard Oil Company of California, died recently in Oakland. Warner, who retired from Standard in 1930, started in the oil business with Buckeye Pipe Line Company and went to Standard early in the century. He became a director and treasurer in 1920.

Edward B. Steward, 60, died recently in Tulsa. A veteran oil man, he was manager of the Ohio Oil Company's Tulsa division, having joined the company in 1919.

Matthew Thomas McGinley, 79, retired oil producer and drilling contractor of Okmulgee, Okla., died October 6. He was a native of Titusville, Penn.

Kenneth R. Farr, 58, vice president of Petrolite Corporation and general manager and sales manager of the Tretolite Company division, died October 3 in St. Louis. He was employed by Wm. S. Barnickel & Company, predecessor of Petrolite Corporation, in 1921. He was named vice president in 1938.

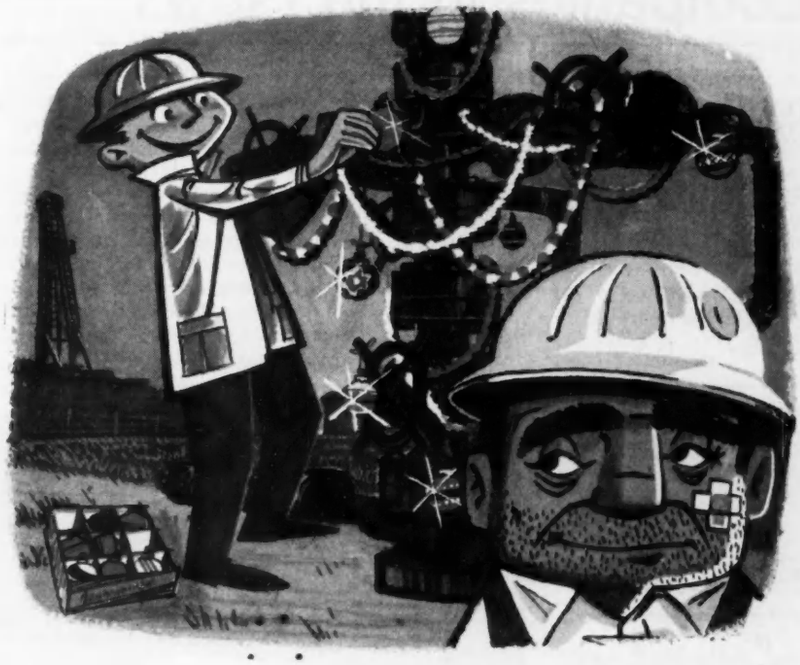
R. W. Rine, 73, died in Colorado Springs September 29. A drilling contractor since 1908, he was founder and chairman of the board of directors of the R. W. Rine Drilling Company of Wichita, Kansas.

Robert E. Donovan, 61, died recently in San Francisco. Manager of the safety division of Standard Oil Company of California since 1947, he joined the company in 1922 as safety engineer in the Producing department. Later appointed chief safety engineer, he organized the safety division for the entire company and won national recognition in the industrial accident prevention field.

E. C. Callahan, 63, assistant secretary-treasurer of the D-X Sunray Oil Company, died October 19. He had worked for the D-X Sunray firm and its predecessors, the Cosden Oil Company and Mid-Continent Petroleum Corporation, since 1919.

Earl Bray, owner and president of Earl Bray, Inc., one of the nation's largest oil transportation companies, died recently at Edmonton, Canada. He lived in Cushing, Okla., and maintained terminals in Tulsa, Oklahoma City, Ponca City and Buffalo, Okla., and at Coffeyville and Augusta, Kansas.

Frank M. Cowell, 37, oil exploration party chief for Seismograph Service Corporation, and a member of the American Association of Petroleum Geologists, died Oct. 11.



"So I says, 'If it's a Christmas Tree... I'll decorate it...'"

The naive young man may not know a Christmas tree from a Christmas tree . . . but here's something you can bet on: veteran Joe Roughneck, symbolic figure of the fabulous oil industry, knows everything about everything concerned with drilling for and producing oil . . . including pipe.

Whether Joe is rendering rugged service on a rig . . or whether he's the brain of a big company . . he knows the kind of quality pipe it takes. More, he knows Lone Star makes it . . and will deliver it on the double! Depend on Lone Star API casing, tubing, and line pipe.

Neighbor, wherever you are,
MERRY CHRISTMAS!

Lone Star STEEL COMPANY

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DISTRICT SALES OFFICES
Houston, Texas | Midland, Texas | San Antonio, Texas
Tulsa, Oklahoma | Wichita Falls, Texas | Shreveport, La.

Companies in the News

TEXAS NATIONAL PETROLEUM COMPANY has been formed through the merger of Johnston Oil and Gas Company and Texam Oil and Gas Company. **Ralph A. Johnston** is chairman of the board, and **W. Stewart Boyle** is president. Offices are in Houston.

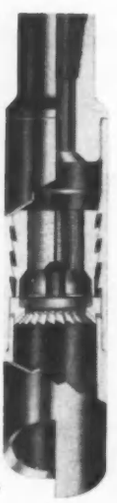
•

THE STANDARD OIL COMPANY (OHIO) has approved, for the fifth successive year, a grant of $35,000 to the Ohio Foundation of Independent Colleges for the 1956-57 school year. Included in this grant are scholarship fees for winners of five new Sohio scholarships for the sons and daughters of Sohio people, to be determined next year. The Sohio scholarship plan is now on a continuing four-year basis, with five new scholarships awarded annually. As in previous years, the five scholarships will be granted to Sohio students entering any of the 24 member colleges in the Ohio Foundation of Independent Colleges.

First choice of operators the world over for retrieving lost sections of drilling or tubing string

The Bowen "Grapple Grip" Principle

Series 150 Overshot Dressed with Spiral Grapple and Parts



Series 150 Overshot Dressed with Basket Grapple and Parts

SERIES 150 (SINGLE BOWL) BOWEN Releasing and Circulating OVERSHOT

Series 150 (Single Bowl) Bowen Releasing and Circulating Overshots are compact units made up of a Top Sub, a Bowl, and a Guide. They can be dressed with standard parts to engage and pack off a specific maximum size or with undersize parts to engage and pack off any smaller sizes.

SIMPLE AND EASY TO DRESS if the OD of the fish is close to the maximum catch of the Overshot, only three parts are required to dress the Overshot to engage and pack it off—a Rubber, a Spiral Grapple, and a Grapple Control. The Rubber drops easily into place in the top of the Bowl.

If the OD of the fish is somewhat below the maximum catch of the Overshot, *only two parts* are required to dress the Overshot to engage and pack it off—a Basket Grapple and a Control Packer. If the top of the fish is apt to be burred or ragged, a Mill Control Packer is used in place of the Control Packer. The teeth will trim the fish and insure perfect performance of the replaceable rubber element and the Grapple. These parts assemble quickly and easily into the Bowl from its lower end. They cannot be assembled incorrectly.

Basket Grapples are a most efficient means for engaging external upset sections or couplings as they can be provided with a solid steel stop in their upper ends to insure location of the fish within their wickered areas.

SETTING AND RELEASING TO THE RIGHT PROVIDES UTMOST SAFETY

The Bowen Overshot both sets and releases TO THE RIGHT so that the fishing string is never turned in an unscrewing direction—a vital safety point.

SIMPLE ACCESSORIES PROVIDE GREAT VERSATILITY

EXTENSIONS: Installed between Top Sub and Bowl of Overshot to allow tool to be lowered over fish with unengageable upper end.

OVERSIZE GUIDES: To adapt overshot to insure alignment of tool with fish in large holes.

MILLING GUIDES: To remove burrs from tool joints or drill collars and to trim ragged pipe.

Bowen Releasing and Circulating Overshots are also made in Multiple Bowl assemblies for two and three sizes of fish. *A Bowen Overshot that can engage and pack off the drilling string at any point of failure should be on every rig floor before drilling is undertaken.*

Write for Descriptive Literature

SR BOWEN CO

MAIN OFFICE AND PLANT:
11008 SOUTH NORWALK BOULEVARD
SANTA FE SPRINGS, CALIFORNIA
EXPORT OFFICE:
30 ROCKEFELLER PLAZA
NEW YORK CITY, NEW YORK
EXPORT REPRESENTATIVE: VAL R. WITTICH, JR.

SHELL OIL COMPANY'S Drilling Rig No. 5 crew members have received commendation for one of the best drilling safety records in the nation. Their record of six years continuous operations in the Brea oil fields without a lost-time accident approaches a national record of seven years set three years ago in Louisiana. Since 1949, Drilling Rig No. 5 crews have amassed more than a quarter-million safe man hours. Headed by Drilling Foreman Ray Ross, the drillers during the six-year period were H. L. McKinley, Harry Iverson, Charley Killen, Dave Goodman and L. C. Coffey.

•

TEKOIL CORPORATION, independent oil and gas producer specializing in secondary recovery, has opened operation and engineering offices in Oklahoma City. Tekoil is the corporate successor to Davison and Company which was organized by W. H. Davison, Tekoil president, and his brother, K. Davison, in 1950 for the basic purpose of rejuvenating oil fields through waterflooding. The Oklahoma City office will be under **K. Davison**, Tekoil vice president and manager of engineering and operations. Also stationed in Oklahoma City is Tekoil's general superintendent **R. L. Shick.**

•

STANOLIND OIL AND GAS COMPANY's division, district and area offices, gasoline plants and individual crews have won a total of 48 safety awards from the American Petroleum Institute, National Safety Council, Joseph A. Holmes Safety Association and the American Association of Oilwell Drilling Contractors. The API award for working one million man-hours without a lost-time injury went to three Stanolind divisions for office, producing and natural gasoline plant operations, and three area operations. The API 500,000-hour award was presented to four Stanolind gasoline plants, five producing areas and one seismograph party. The company's exploration operations' safety record earned the National Safety Council's Award of Merit, while other NSC awards went to natural gasoline, producing, refining and manufacturing operations. Joseph A. Holmes safety awards were presented for plant and producing operations, Rocky Mountain division; exploration operations, Central division; and production research operations. Holmes awards also went to nine Stanolind areas, five plants, four seismograph parties and one pipe line operation. The AAODC conferred safety award certificates to four toolpushers and ten drillers, and presented award cards to 100 drilling crew members.

•

SUNRAY MID-CONTINENT OIL COMPANY has established an Evaluation department headed by **Dr. C. W. Ziemer.** Three technical assistants who will work with Ziemer in the new department are **J. Henry Blackburn,** senior log analyst, and **Arthur W. Wadman, Jr.** and **Edwin H. Barsachs,** reservoir engineers. Ziemer previously was chief reservoir engineer in Sunray Mid-Continent's Production department. He will now direct reserve and economic evaluation studies of new field discoveries, properties being developed and those considered for acquisition.

CULLEN MINERALS CORPORATION has begun acquisition and operation of its first oil and gas properties. **Lucien Hugh Cullen** of Houston is president of the new firm which will develop and operate oil, gas and minerals properties in the U. S. and abroad. **Joe R. Abercrombie**, director and vice president, will be in charge of CMC's oil and gas division field operations. He formerly was a partner and in charge of drilling operations for J. S. Abercrombie & Company in the Old Ocean field in Texas. **K. Douglas Kaasch**, geologist and mining engineer formerly with Climax Molybdenum Company in the Four Corners area, and **Ralph H. Wilpoit**, geologist and former deputy director of explorations for the Atomic Energy Commission at Grand Junction, Colo., will be in charge of CMC's geological exploration and research program. **John N. Mitchell**, senior partner in New York law firm of Caldwell, Marshall, Trimble and Mitchell, has been elected as a director and a member of the company's executive committee. **James E. Kelly**, Denver newspaper executive, and **W. R. Smith**, San Antonio attorney, have been elected vice presidents and directors. **H. J. Gravis**, oil man and rancher of San Diego, Texas, has been elected a director and member of the executive committee.

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CONTINENTAL OIL COMPANY has won the National Safety Council's highest award, the Award of Honor, for the third consecutive year. The award is presented to a company whose safety record is considerably better than the national industry record, and better than the company's record for three years preceding the year in which the award is given. Continental had 71 percent less lost-time accidents in 1954 than the oil industry average, and its number of days lost because of accidents during the year was 93 percent below the industry average.

•

DELHI-TAYLOR OIL CORPORATION has announced the transfer of its Kansas-Oklahoma district production office from Chanute, Kansas, to Tulsa. The transfer was made necessary by the general expansion of Delhi-Taylor operations in the district. Staffing the new office are **Ernest W. Adams**, superintendent, and **Llewellyn C. Ward**, engineer. Adams has been active in petroleum exploration since 1925, when he began as a driller. He has been in charge of the Chanute office for the past 18 months.

•

HUMBLE OIL & REFINING COMPANY and **HUMBLE PIPE LINE COMPANY** employes recently were presented the National Safety Council's highest award, the Award of Honor, for outstanding safety achievement during 1954. The award represents at least a 30 percent reduction in accident frequency and severity from the companies' and the industry's average rates for three previous years. Humble employes reduced the frequency rate 62 percent and the severity rate 74 percent. Their 1954 frequency rate was 2.24 disabling injuries per million manhours worked.

•

LION OIL COMPANY and **MONSANTO CHEMICAL COMPANY** shareowners recently approved a merger previously agreed upon by the directors of both corporations. **T. H. Barton**, board chairman, and **T. M. Martin**, president of Lion, have become members of the Monsanto board. Lion will be a division of Monsanto. Martin is to serve as president of the Lion division and, in addition, has been elected a vice president of Monsanto. **Jeff Davis**, vice president and general counsel of Lion, has been elected an assistant secretary of Monsanto, and **E. W. Atkinson**, vice president and treasurer of Lion, has been elected an assistant treasurer.

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STANOLIND OIL AND GAS COMPANY has established two new district offices in Calgary to supervise exploration operations in the provinces of Alberta, Saskatchewan, Manitoba and British Columbia. One of the offices will serve an area designated as the Calgary district, which includes all of Alberta south of Edmonton, as well as all of Saskatchewan and Manitoba. The North Canadian district comprises northern Alberta and all other territory in the Canadian division. **M. R. Erickson**, named district exploration superintendent in charge of the Calgary district office, will be located at 308 Ninth Avenue West, in the same building occupied by the Canadian division office. **D. E. Powley** will be district geologist, **A. H. Jukes**, district landman, and **A. J. Hearst**, district exploration clerk. The North Canadian district office will be located at 326 Ninth Avenue West, and will be headed by **C. L. Cain**, who has been promoted to district exploration superintendent. Others in this office include **H. A. Baker**, district geologist; **N. H. Bartley**, district landman; **C. A. Willner**, district geophysicist; and **M. J. Cush**, district exploration clerk.

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What Facts Do You Want?

Rig Runner automatically produces a record of procedure for the engineer, a drilling report for the driller, a complete record for the toolpusher. Rig Runner shows accurate drilling time for the geologist and gives management a complete breakdown of costs.

There is something for everyone on a Rig Runner chart. This chart is accurate and is made automatically. It points the way to savings all the way from spudding in to TD. Write for more information showing what Rig Runner can do for you.

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Export Representative: International Oil Equipment Co.
30 Rockefeller Plaza, New York City

(For more data on advertised products, use Readers' Service blue cards, last page this issue.)

What's Happening

AMONG INDUSTRY ASSOCIATIONS

Win New York Tourney

Four of the prize winners in the New York Nomads Fall golf party were, left to right, H. Leonard, Midwest Piping Company, low gross guest; H. Shuttler, Socony Mobil Oil Company, high gross guest; R. Meek, Ladish Company, president's cup for Nomad total low gross scores at both June and September parties; and B. Foy, International General Electric Company, high gross Nomad. Eighty-eight golfers participated in the one-day tournament.

API Creates New Division Of Finance and Accounting

Creation of a new division, to be known as the Division of Finance and Accounting, was announced recently by the American Petroleum Institute. The new Division will replace the Financial and Accounting Committee, which has been in existence for 30 years.

Vice president for the new division will be appointed by the Institute's board chairman.

President Frank M. Porter said the reasons for the organizational changes are:

To recognize within the Institute the tremendous evolutionary advances which have taken place in the corporate financial and accounting structure of the oil industry.

To bring within the democratic framework of the Institute organization the industry's enlarged and continuously expanding financial and accounting functions.

To give the financial and accounting organization sufficient depth and breadth to enable it to assume on an industry basis appropriate responsibilities.

The recommendation for divisional status was made by the Financial and Accounting Committee itself, of which P. C. Salman, of Socony Mobil Oil Company, Inc., is the current chairman.

Present membership of the Financial and Accounting Committee will serve as the nucleus for the new division. Once the organizational changeover is completed, the membership is to be expanded.

Geological Society Elects Kerlin 1956 President

M. L. Kerlin, Shell Oil Company, heads the new slate of officers recently elected by the New Orleans Geological Society. Lyle Harvey, with John W. Mecom, is vice president for the 1955-56 term; C. A. Brooke, Stanolind Oil and Gas Company, is secretary; and D. D. Wingfield, Monterey Oil Company, is treasurer.

Houston Hosts International Visitors

George B. Saunders, Mene Grande Oil Company, San Tome, Venezuela; Henry Reed, Lehman Bros., New York; Joao Lopes Da Silva, Socony Vacuum, Lisbon, Portugal; Clinton O. Williams, University of Houston, Houston; and B. C. Corbin, Byron Jackson, Mt. Carmi, Ill., above on the front row, left to right, were among the international guests at a recent Nomads meeting in Houston. Also attending were, back row, left to right, H. J. Baker, Iraq. Petroleum Company, Kirkuk, Iraq; J. C. Kiker, Texas Petroleum Company, Caracas, Venezuela; E. P. Markham, Mene Grande Oil Company, San Tome; E. W. Paddock, British Petroleum Ltd., Khanek, Iraq; Charles Wickens, Shell D'Arcy, Owerri, Nigeria, West Africa; D. V. Smith, Heathman-Seelighson, Pescara, Italy; and John M. Hardy, Hardy-Griffin Engineering Company, Houston.

NACE South Central Region Announces 1956 Officers

The National Association of Corrosion Engineers' South Central Region has elected John W. Nee chairman for a one-year term beginning January 1, 1956. Nee is vice president and technical director of the Briner Paint Manufacturing Company of Corpus Christi, Texas. The South Central region covers the area from New Orleans to Denver and includes seven states: Texas, New Mexico, Colorado, Kansas, Oklahoma, Arkansas and Louisiana.

Other officers elected for a one-year term are Vice Chairman Jack P. Barrett, Stanolind Oil & Gas Company; Secretary-Treasurer J. C. Spalding, Jr., Sun Oil Company; and Assistant Secretary-Treasurer J. A. Caldwell, Humble Oil & Refining Company. Harry E. Waldrip, Gulf Oil Corporation, was elected director for a three-year term beginning in March, 1956.

Houston Engineers Club Plans Gulf Coast Center

Plans for a Technical and Scientific Center which will make Houston the engineering headquarters of the Southwest were announced recently by the Houston Engineers Club. The new center, sponsored by the Houston group, will provide space and professional services for the more than 9000 members of Houston's 35 technical societies and engineering groups.

A $300,000 rebuilding program will add conference rooms, lecture halls, reading and reference rooms, dining and banquet rooms, storage space and offices for the Houston club in the present club building. In addition to conference and lecture facilities, the new headquarters will provide a complete secretarial service and employment service.

Maurice Dickinson to Head Los Angeles Engineers Club

Maurice L. Dickinson, chief hydraulic engineer for Bechtel Corporation, has been elected president of the Engineers Club of Los Angeles. Other officers elected at the meeting of the board of directors include L. W. Chasteen, valuation engineer for Union Oil Company, vice president; Robert F. Stewart, sales manager of Western Precipitation Corporation, secretary; and Wallace W. Kenney, sales engineer for Graybar Electric Company, treasurer.

J. Calvin Brown, past president of the American Society of Mechanical Engineers and the Engineers' Council of Los Angeles, was elected unanimously to serve as chairman of the board, with other directors of the Engineers Club including Dr. A. M. Zarem, manager of the Southern California division of Stanford Research Institute; Thomas F. Edson, consulting engineer; Richard E. Lauterbach, manager of manufacturing for General Petroleum Company; Milan G. Arthur, chief valuation engineer for Union Oil Company; and Finley B. Laverty, chief hydraulic engineer for the Los Angeles County Flood Control District.

What's Happening

AMONG SERVICE AND SUPPLY MEN

A. K. Babel

L. H. Brothers

J. R. Forbes

William H. Norman

Glen E. Wilbur

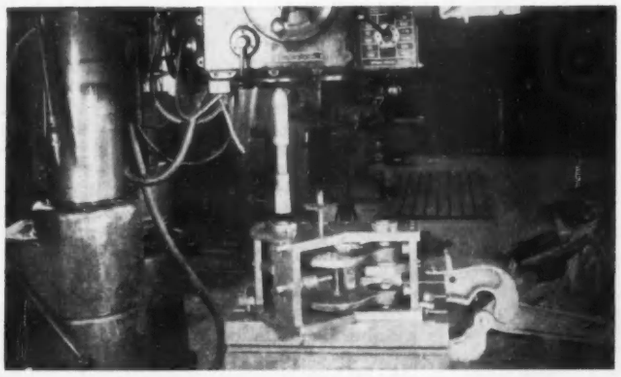
Hal J. Jones

Hughes Tool Company announces the promotion of **A. K. Babel** to division sales manager of northern South America, with headquarters in Maracaibo, Venezuela. With the company since 1940, he has served as sales representative in the Mid-Continent fields and, since 1948, has been in South America. Promotion of **L. H. Brothers** to special representative and his transfer to Venezuela also is announced. Formerly district sales manager at Corpus Christi, he had represented Hughes in the Gulf Coast area 15 years. **J. R. Forbes**, in sales and field service work in East Texas and San Antonio since 1938, was named district sales manager at Corpus Christi.

Axelson Manufacturing Company, Division of U. S. Industries, Inc., recently announced the appointment of **William H. Norman** as factory representative for the Overton-Kilgore, Texas area. He formerly was with Sperry-Sun Well Surveying Company and Baroid.

Glen E. Wilbur, formerly of the Petroleum Extension Service at the University of Texas, is now public relations director of **Weatherford Oil Tool Company.** Prior to joining the Petroleum Extension Service in 1952, he administered training programs for Sun Oil Company.

Dr. Hal J. Jones, appointed chief engineer of **Houston Technical Laboratories,** petroleum instrumentation subsidiary of Texas Instruments Incorporated, formerly was director of geophysical research in the TI Research division in Dallas. He will be succeeded by **Dr. John A. F. Gerrard,** director of geophysical research at HTL. Jones, who has been heading geophysical research at Texas Instruments three years, formerly was with Stanolind Oil & Gas Corporation, Engineering Research Associates and Shell Oil Company. At Houston Technical Laboratories, he will be responsible for design and development of all instruments and products.



When Your Equipment Needs Repairs . . . . Call S & R

Fast service by men experienced in equipment repairs, using factory parts and complete inspection . . . that's the way it is done by S&R. And these are the reasons many contractors and oil companies are turning to S&R for all their equipment repairs. Let S&R do your next repair job, whether it be tongs, elevators, rotaries, blocks, pumps, etc.

Other S&R services and products: General and special machine shop facilities, equipment unitizing, fabrication, power application and devices, mud pits, tool, change and utility houses, conveyors, telescoping pole masts, and pump suction strainers.

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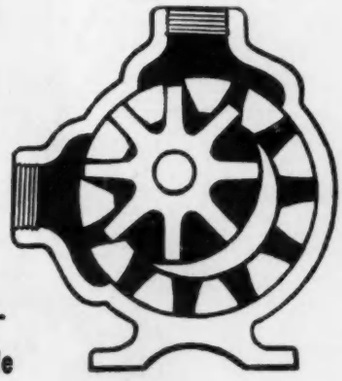
Houston 1, Texas
Export: 45 Rockefeller Plaza, New York 20, N. Y.

VIKING ROTARY PUMPS



• Cut-Away View Showing Viking's Gear-Within-A-Gear Principle

The unique and unusually simple construction of Viking Pumps . . . with only two moving parts . . . assures you of long, easy-maintenance operation with all grit-free liquids.

Let Southern Engine & Pump Company show you how Viking Pumps can solve your pumping problems. We invite your inquiries.

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Corpus Christi and Beaumont, Texas.

STAY ON BOTTOM LONGER WITH THE RIGHT EQUIPMENT

Round trip time is not only non-productive—it also adds to the wear and tear of your rig and to your cost per foot of making hole.

Round trips cannot be eliminated but they can be reduced. Actual cases throughout the country show that diamond drilling bits stay on bottom longer, drill a straighter hole and require less weight.

You can save time and money by using one of the many varieties of Christensen Diamond Drilling Bits, manufactured in any size and designed to fit your particular drilling conditions.

Take advantage of a Christensen Diamond Drilling Bit by (1) outright purchase—you pay for the diamonds in the bit plus a setting charge. Upon return of the used bit you are credited with diamonds salvaged; (2) rental basis—you gain the advantages of a diamond drilling bit at a predetermined price per foot, and have the added advantage of knowing bit cost per foot well in advance of the drilling operation.

CHRISTENSEN DIAMOND PRODUCTS

1937 SOUTH 2nd WEST SALT LAKE CITY, UTAH

John J. Neale

Jas. D. Hughes

John J. Neale, president, **Lane-Wells Company**, one of the Dresser Industries, has announced that **Jas. D. Hughes**, formerly vice president-sales, will direct sales and service activities of the company. **K. H. Miner**, formerly vice president of Petro-Tech Service Company, is assuming an assignment as acting manager-engineering, manufacturing and purchasing. **R. M. Otis** continues as vice president-research and patents. **John C. Stick, Jr.**, formerly the company's chief geophysical engineer, has been appointed chief engineer in the absence of **V. L. Forsyth**, who is temporarily on special assignment as administrative assistant to the president. **J. Shannon Baker** has assumed the duties of the chief geophysical engineer. **R. W. Keener**, formerly vice president of Petro-Tech, a Lane-Wells foreign subsidiary, was named manager foreign sales and service. **J. M. Henderson**, Gulf Coast division manager, has been promoted to manager-sales and service for the company, and **R. E. Bush** has been advanced to manager of the Gulf Coast division.

General Motors Electro-Motive division announces the appointment of **Donald H. Queeney** as industrial sales manager.

Jud L. Felts and **Morgan Hanson** have been appointed district managers by **B and W, Inc.**, Houston manufacturers of scratchers and centralizers. Felts, who transferred from Harvey, La., is B and W's new manager of the Eastern district, covering north and south Louisiana, East Texas, Arkansas and Mississippi. Hanson, who transferred from Abilene, will manage the Western district, covering north and West Texas, New Mexico and the Rocky Mountain area.

Robert C. Houser has been elected treasurer of **H. K. Porter Company, Inc. Rocco J. DiFonso** has been named assistant treasurer and **Edward R. Moran**, assistant secretary. Houser, who joined Porter a little more than a year ago as assistant treasurer, previously had been manager of the Pittsburgh office of Peat, Marwick, Mitchell & Company. Moran, before joining Porter, was a partner in the law firm of Cobourn, Yager, Notnagel, Smith & Moran. DiFonso was with the Bureau of Internal Revenue before joining Porter's Accounting department in 1951.

Robert M. Van Tassel is now head industrial designer for **Joy Manufacturing Company**, attached to the Pittsburgh executive staff. Formerly engaged in product development and design for the Cadillac division of General Motors, he has been with Joy seven years. In El Paso, **J. E. Douglas** has been named district sales manager for Joy, succeeding **E. E. Miller**, who has retired after 43 years with the company. Joining the company in 1945, Douglas was appointed assistant district sales manager at El Paso earlier this year.

(For more data on advertised products, use Readers' Service blue cards, last page this issue.)

L. F. Williams

James E. Brown

Thomas J. Delaney

R. A. Fryer

Jack Dugan

Jack G. Walker

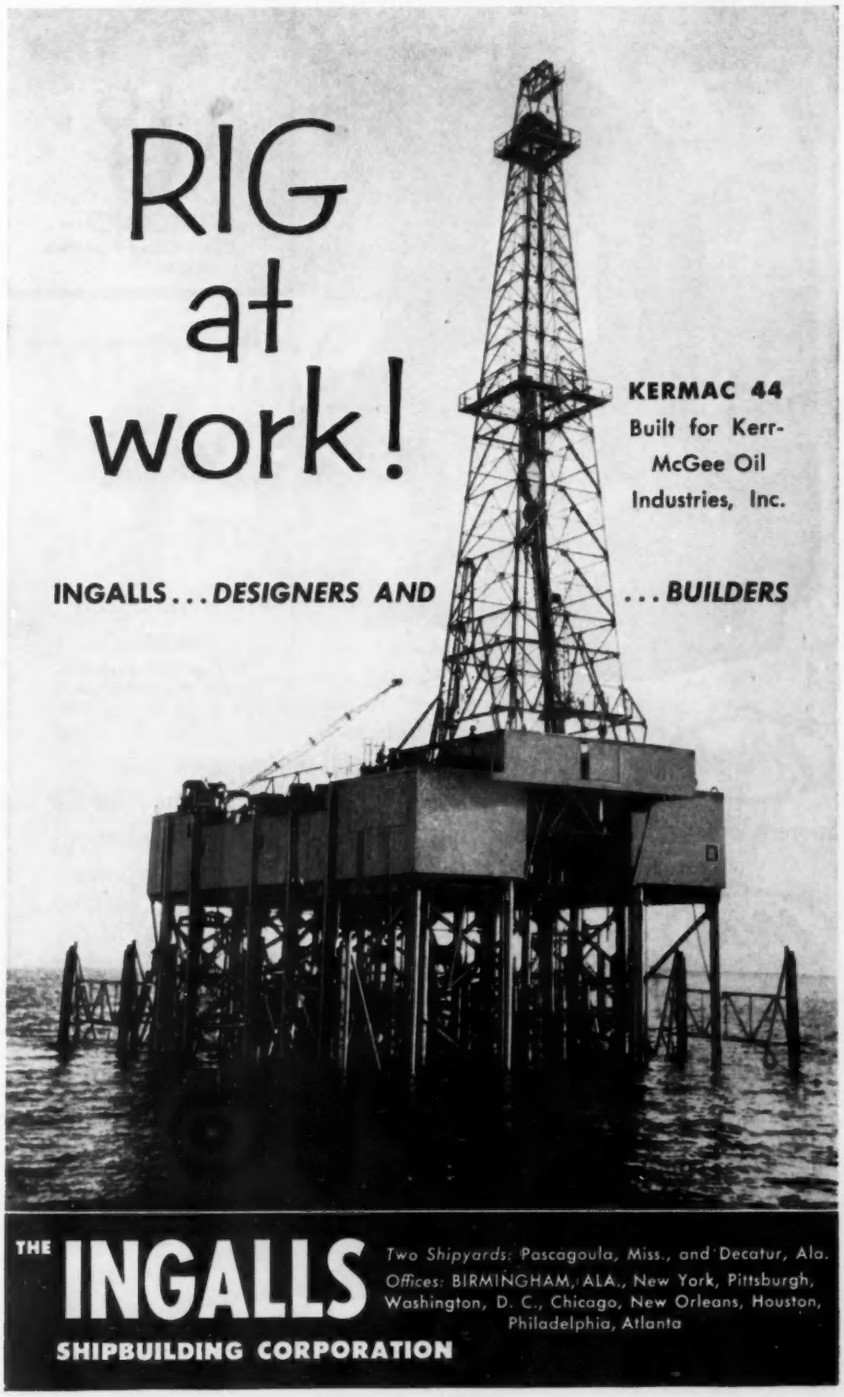
Lawrence **F. Williams** was elected president of **The Cooper-Bessemer Corporation** at a recent directors' meeting. He succeeds **Gordon Lefebvre** who resigned after 14 years as head officer of the company. **James E. Brown,** treasurer of Cooper-Bessemer, was elected to serve also as secretary of the company, replacing Williams. Formerly a director and secretary of Cooper-Bessemer, Williams has held numerous positions in the management of both the company's plants in Mount Vernon, Ohio, and Grove City, Penn. Starting with the company as a lathe operator, he successively was advanced to key manufacturing positions. He was elected assistant secretary and director of the company in 1939, and in 1947 advanced to secretary and assistant to the president. Since joining Cooper-Bessemer in 1927, Brown has held various accounting and financial positions. In 1947 he was elected treasurer, and subsequently was elected to positions of director and vice president of Cooper-Bessemer International; director and treasurer of Cooper-Bessemer of Canada, Ltd.

Thomas J. Delaney has been named director of advertising and sales promotion for **The White Motor Company; R. A. Fryer** has been named assistant director of the enlarged department, with headquarters at Cleveland. The two promotions were made in line with the consolidation of the Autocar and White sales promotion departments and the expansion of the sales program. Delaney formerly was director of sales promotion and advertising for White's Autocar division. He joined Autocar more than 20 years ago as a salesman, later advancing to director of manufacturing research and public relations director. Fryer has been manager of the White sales promotion department for five years and has been with White for the past 12 years.

Jack Dugan, formerly Southwestern field engineer for Cook Electric Company, has been appointed Southwestern district manager for the **United States Motors Corporation.** With offices in Houston, he will work with company dealers and distributors in New Mexico, Texas, Oklahoma, Arkansas and Louisiana.

Jack G. Walker, appointed special sales representative for the **Milwhite Mud Sales Company,** will be in charge of export and industrial sales, a new department organized to implement Milwhite's expansion program. Previously, he worked as export sales manager for another mud company, remaining with that company several years. In his new position, Walker's headquarters will be in Houston at Milwhite's home office in the M&M building.

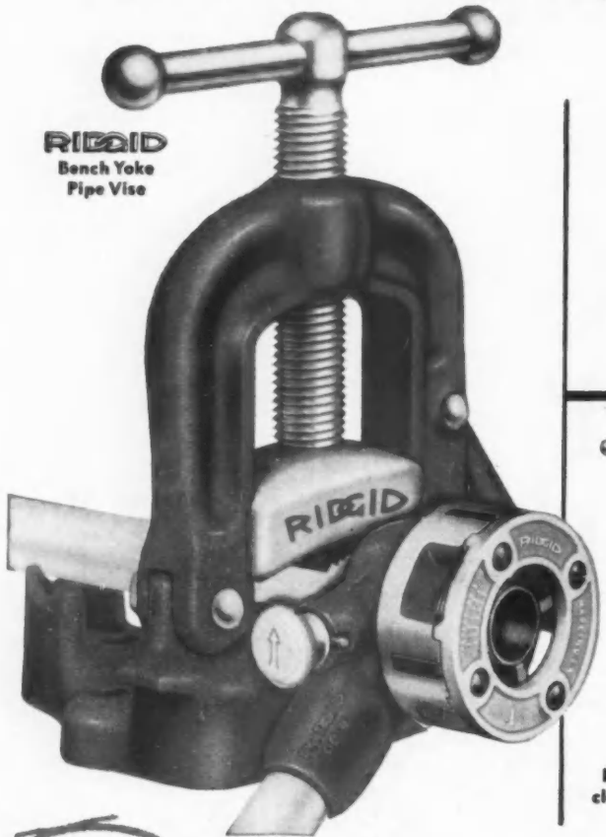
Fluid Packed Pump Company announces the appointment of **R. C. (Bob) Thompson** as Fluid Packed Pump Company's export representative. He will work with their distributor, The National Supply Company, to service Oilmaster products throughout Latin America, making his headquarters in Maracaibo, Venezuela.


RIG
at
work!
KERMAC 44
Built for Kerr-McGee Oil Industries, Inc.
INGALLS... DESIGNERS AND ...BUILDERS
THE INGALLS SHIPBUILDING CORPORATION
Two Shipyards: Pascagoula, Miss., and Decatur, Ala.
Offices: BIRMINGHAM, ALA., New York, Pittsburgh, Washington, D. C., Chicago, New Orleans, Houston, Philadelphia, Atlanta

You get *More* for your money when it's a work-saver

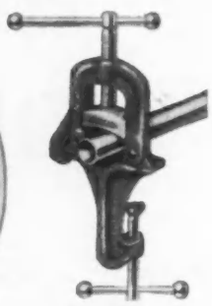
RIDGID

Yoke or Chain Type
Bench, Kit or Post Pipe Vise



RIDGID Bench Yoke Pipe Vise

RIDGID Bench Chain Pipe Vise



RIDGID Kit Pipe Vise, portable, clamps on bench or plank

More **efficiency...** special design jaws that grip firmly . . . close and open fast . . . pipe rests for more accurate threading, easy cutting . . . handy pipe benders.

More **service...** famous RIDGID heat-treated jaws for extra long wear . . . special malleable frames that won't warp or break . . . every vise factory tested to assure you super-performance and durability.

Get most for your money—buy RIDGID Vises, including stand and tristand, at your Supply House!

The Ridge Tool Company • Elyria, Ohio • U.S.A.

Stanley L. Furman

Richard A. Heckel

Stanley L. Furman, appointed an assistant treasurer of **The National Supply Company**, joined the company in 1936, following basic credit experience with a major oil company. Assigned to the credit department of the Eastern division, he was promoted to chief clerk in 1942, assistant credit manager, 1944, and division credit manager, 1948. He was named assistant general credit manager in 1951. Furman will have headquarters in Tulsa where he will direct the treasury and credit affairs of the company's Midwest and Northwest divisions. **Richard A. Heckel**, promoted to assistant division manager of the Midwest division at Tulsa, joined National Supply in 1926. Subsequently he worked at company stores in Kansas and Oklahoma City. In 1953 he was made assistant division sales manager.

Magnet Cove Barium Corporation has announced seven promotions in the Sales and Service department. Three engineers in the Texas-Gulf Coast division will assume the duties of district engineer in that division: **Robert J. McGannon** in the Corpus Christi district; **Robert B. Sheppard** in the Victoria district; and **James E. Smith** in the Houston district. McGannon joined Magcobar in 1951. Sheppard and Smith both have been with the company since 1952. **Hershel Penton**, formerly an engineer in New Iberia, La., has been named district manager in Plaquemine, La., in the Southeastern division. He has been employed by Magnet Cove since 1951. **Thomas Cox** is the new division sales manager for Magcobar's Mid-Continent division in Tulsa. Formerly district manager in Oklahoma City, Cox has been with the company since 1950. **Kenneth Kirkland**, a former engineer in Liberal, Kansas, is now district manager in Liberal. He has been with the company since 1952. New manager of the Pampa, Texas, district in the Fort Worth division is **Earl Luther**, formerly an engineer in Pampa. Luther has been with Magcobar since 1949.

M. T. Sprague has been named Oakland, Calif., district manager by the motor truck division of **International Harvester Company** to succeed **Roy A. Legge**, retired. Sprague, a veteran of 18 years' service with IH, was formerly Portland, Ore., International truck district manager, and also served in various sales capacities previously at Denver and Los Angeles. Legge retired after 37 years with the company, the last 27 of which were spent as manager of the Oakland truck district. **G. S. Stewart**, formerly assistant to Sprague at Portland, has been named district manager there. Promoted to Portland assistant district manager is **R. M. Beauchamp**, who managed the International branch operation at Seattle.

Ralph C. Moffitt

William H. Lang

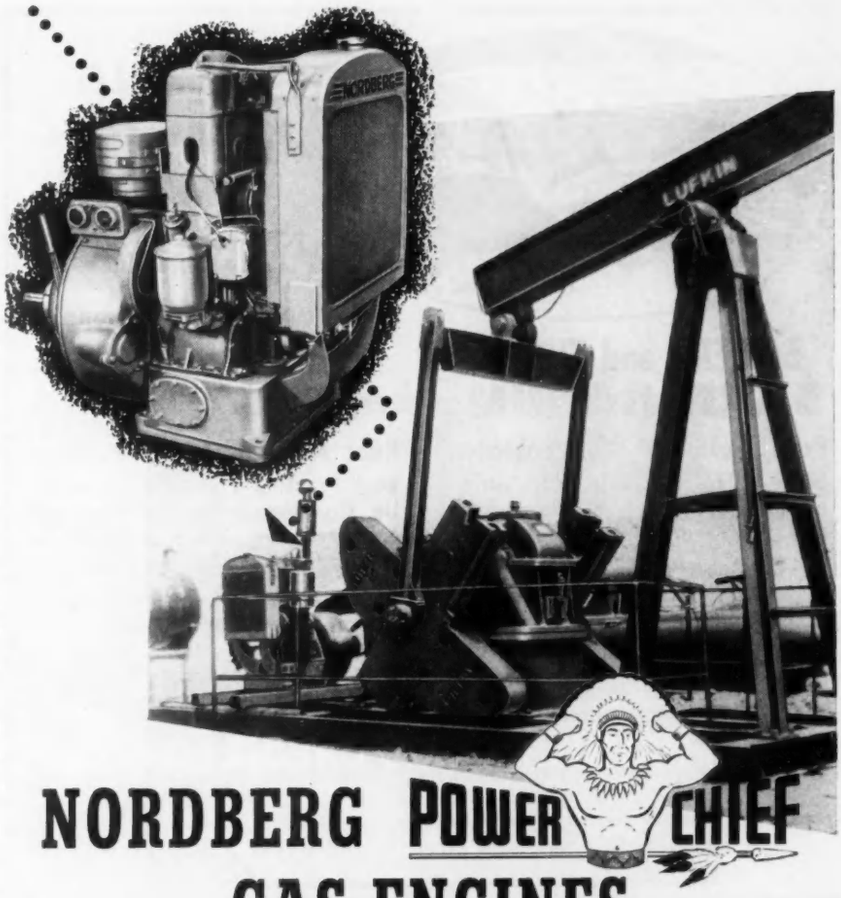
Ralph C. Moffitt, new assistant vice president and director of purchases of **United States Steel Corporation,** will retain his present responsibilities and assume those of **R. L. Van Cleve,** assistant vice president—purchases, who is retiring after 41 years with the company. Moffitt joined U. S. Steel in the Purchasing department of the Columbia Steel Company and, in 1947, was appointed assistant vice president—purchases of the U. S. Steel Corporation of Delaware. Named director of purchases of U. S. Steel Company in 1951, he became director of purchases of the U. S. Steel Corporation two years later. **William H. Lang,** recently appointed assistant vice president, U. S. Steel Corporation, will continue in his present position as assistant treasurer of the corporation and president, U. S. Steel Homes Credit Corporation, in addition to his new position.

Hubert B. Smith, appointed director of product engineering at the Claymont, Del., plant of **The Colorado Fuel and Iron Corporation,** will supervise production at the plant in all stages from research and development of products and processes to control of quality. Smith formerly was vice president in charge of research with Great Lakes Steel Corporation.

Jimmy G. Biles, a wire line specialist for **Otis Pressure Control, Inc.,** in its Falfurrias, Texas, branch, has been transferred to Maracaibo, Venezuela, with Servicio Tecnico de Pozos "Otis" C. A., South American affiliate company of Otis. Biles began with Otis in its Corpus Christi division.

General American Transportation Corporation announces that **Grant Ingraham** has been appointed director of purchases, with offices in Chicago. Ingraham joined General American in 1922 and rose from clerk in the Purchasing department to general purchasing agent. Two other appointments announced by the company were **W. O. Graham,** who joined General American in 1927, appointed assistant director of purchases; and **Duane J. Hicks,** who has been with the company since 1929, named general purchasing agent. **J. C. Vorhauer** recently moved from vice president and director of purchases to vice president in charge of special sales.

Joseph H. Barry, appointed socket screw sales representative in the Pittsburgh-Buffalo area for the Socket Screw division of **The Bristol Company,** has been with the company over 15 years. He was with the Aircraft division, and, later, the Industrial Instruments division. He will work out of the company's Buffalo headquarters.



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keep production on schedule . . .

Here's the low cost answer to compact, dependable power for 'round-the-clock production pumping—the new Nordberg *POWER CHIEF* Gas Engine. Backed by many years of service to the petroleum industry, this Nordberg engine is ruggedly built to keep production on schedule day-in and day-out, even under the most severe operating conditions.

Available as straight power units, rated 18 hp max., with stub shaft or clutch power take-off . . . and as "packaged" generator sets producing up to 10 kw, Nordberg *POWER CHIEF* Gas Engines are simple to install and easy to maintain —always ready and able to serve you 24 hours a day. Clip the coupon for full details.

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(For more data on advertised products, use Readers' Service blue cards, last page this issue.)

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Your Operations!

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Since 1926 the safe, sure and economical means of Removing and Preventing Boiler Scale and Corrosion.

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Exceeds rigid industrial and military specifications.

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get **ALL** the facts

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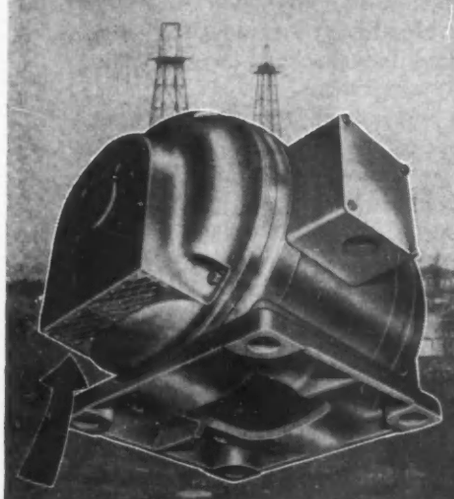
FIELDMASTER

BALL BEARING MOTORS



Like a book, you can't tell a motor by its cover; it's what's **inside** that counts.

FIELDMASTER Ball Bearing Motors, for example, have been specially designed and built to more than handle the rugged requirements of oil field use. High slip is available to take care of reciprocating load requirements encountered in pumping . . . wide variety of windings provides triple ratings, dual voltages . . . high torque licks heavy starting problems . . . high-grade silicon steel in the magnetic circuit reduces iron losses . . . heavy-duty, double-shielded pre-lubricated bearings increase performance, reduce lubrication problems . . . heavy cast base assures alignment stability.

These are just a few of the many facts which prove FIELDMASTER Ball Bearing Motors are second to none. Our distributor, the Bethlehem Supply Company, will gladly supply you with **ALL** the facts . . . **without obligation.** May we have them contact you?

Screened Air Port Keeps Out Rodents!

VALLEY ELECTRIC CORP. 4221 FOREST PARK BLVD., ST. LOUIS, MO.
Distributor, BETHLEHEM SUPPLY CO., TULSA, OKLA.

William E. Goodere

George L. Robb

William E. Goodere has been appointed district sales engineer for **The Ingalls Iron Works Company** and its subsidiaries, The Ingalls Shipbuilding Corporation, The Ingalls Steel Construction Company and Birmingham Tank Company. He will have offices in Houston. For two years Goodere has been construction representative with Todd Shipyards Corporation. Prior to that, he was sales manager of the Farnsworth and Chambers Company and the Consolidated Western Constructors.

George L. Robb, geological engineer, has joined the geophysical department of **Century Geophysical Corporation.** He has 16 years experience in the field of geology and the geophysical exploration industry.

J. M. Hollingsworth is new sales manager for **Lone Star Steel Company's** District 1, comprising Dallas, Fort Worth and East Texas. **R. R. Reed**, sales representative, also has been assigned to the district offices to be opened soon in Dallas' Republic Bank building. Holingsworth joined Lone Star's sales department in 1949.

The New York Air Brake Company's Kinney Manufacturing division has named **W. H. Crowley** chief engineer in charge of all Kinney engineering activities including production, development, research and vacuum systems and equipment. Crowley joined Kinney in 1950 as product designer. He later became chief draftsman and assistant chief engineer. Appointment of **J. Raymond Marshall** to equipment sales engineer also has been announced. He formerly was with Sylvania Electric Products, Inc. **Arthur J. Shivers, Jr.** has been named to represent Kinney in the Philadelphia area as sales engineer; **Jackson A. Brower** has been added to the New York district sales staff; and **Thomas A. Sowin** has joined the company's Chicago district sales staff.

Lane-Wells Company, one of the Dresser Industries, announces the appointment of **C. F. Ludwig** as acting division manager of the Pacific Coast division. With the company 18 years, he has held position in all three of the domestic divisions, as well as in the Lane-Well Canadian Company, of which he was vice president from 1949 until 1951. Since 1951, Ludwig has been assistant manager of the Pacific Coast division.

Ideco, one of the Dresser Industries, recently announced the appointment of **King D. Boyd** to the new position of technical service manager at Ideco headquarters in Dallas. Boyd joined Ideco after serving as petroleum sales manager for Stewart & Stevenson seven years.

Angus J. O'Brien

T. G. McLaughlin

Gar Wood Industries, Inc., recently announced the appointment of **Angus J. O'Brien** to the newly-created position of vice president and director of engineering and manufacturing. In his new position, O'Brien is responsible for all Gar Wood's manufacturing and engineering activities. With Gar Wood as vice president and director of manufacturing since 1949, he came to the company from Fisher Body Division, General Motors Corporation. His early training was with the Ford Motor Company.

Higgins, Inc., New Orleans shipyard, has appointed **Thomas G. McLaughlin** works manager. McLaughlin has been engaged in shipbuilding activities for the past 25 years in capacities ranging from loftsman through production planning, engineering and plant management.

George Erbe of Houston has returned to active duty as a district representative for the **Gorman-Rupp Company** after recovering from injuries received in an automobile accident. Erbe's territory for the pump manufacturing concern covers the Southwestern states.

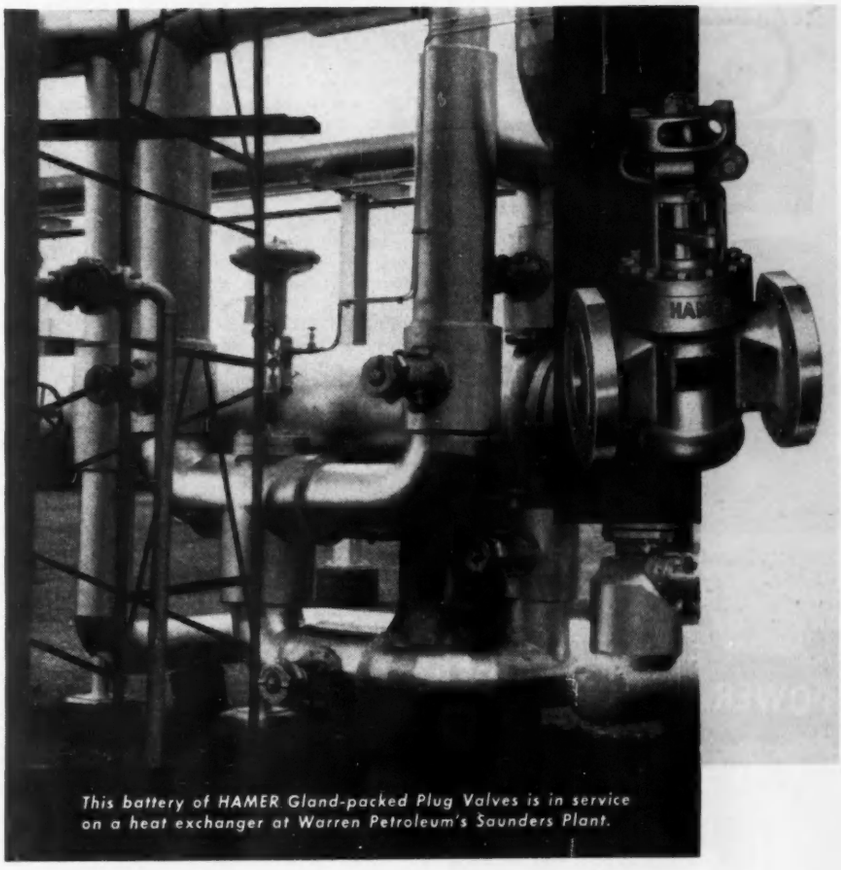
Universal Oil Products Company has elected **F. O. Newton** to the newly-created position of vice president with responsibility for supply and distribution, and named **W. J. Peck**, an assistant secretary of the company. For the last ten years, Newton has been engaged in special project work, and since 1952, has been assistant to the executive vice president. He is a director of Universal-Matthey Products, Limited, a subsidiary of UOP. Peck, a member of Universal's legal staff, has been with the company since 1953. Prior to that he was assistant U. S. attorney for the District of Columbia in charge of the appellate section. **M. P. Venema** and **A. Nye Van Vleck** have been elected to the board of directors of Universal. Venema, who has been with the company more than 20 years, became successively a member of the patent department, patent representative in Washington, vice president and executive vice president. Van Vleck practiced law in Washington until 1919 when he became associated with The Guaranty Trust Company of New York.

R. J. Murphy has been appointed sales manager of **The New York Air Brake Company's** Hydreco and Dudco divisions, manufacturers of hydraulic control equipment. His headquarters will be in Cleveland. He was formerly assistant sales manager of both divisions. Before joining the company in 1953, he was assistant sales manager of the Hydraulics division, Sundstrand Machine Tool Company.

You can repack

HAMER G. P. PLUG VALVES

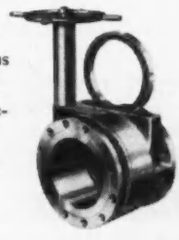
under full operating conditions



This battery of HAMER Gland-packed Plug Valves is in service on a heat exchanger at Warren Petroleum's Saunders Plant.

HAMER *Line Blind Valves*

Built for strength and durability, Hamer Line Blind Valves are the modern means of blinding pipe lines quickly and effectively. A one-man, one-minute operation. Cuts costs, and speeds up operations.



Shutting down to change valve packings costs dearly in time and money. That's why Warren Petroleum uses Hamer gland-packed Plug Valves. Not only can Hamer gland-packed plug valves be repacked under full operating conditions, but because of the exclusive plug adjusting nut, a feature of all Hamer Plug Valves, the valves can't stick or freeze. No matter what the time lapse or service you have positive E-Z turn control at all times.

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It Doesn't Cost Anything to Find Out That BRAKESOL Will Work!

Our Sales Engineers are available in all parts of the oil country to show what BRAKESOL will do for your particular Paraffin problem. We do not ask anyone to buy until they have been shown. Just contact your nearest Supply Store to arrange for a FREE field test.

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HOLDS PARAFFIN IN SUSPENSION from FORMATION to REFINERY

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POWER PISTON RINGS

Centrifugally cast for long life!

Heat tensioned for ideal shape—designed to develop maximum power — maintain efficient oil control.

FRANCE MAKES THEM!

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Thomas W. Painter

John G. Richards

Thomas W. Painter, vice president for administration of **Welex Jet Services, Inc.** was elected to the board of directors at the annual stockholder's meeting of the oil well service company. Painter, who joined Welex in 1950, has been in charge of the administrative and manufacturing divisions. Prior to joining the company, he was comptroller of the Texasteel Manufacturing Company.

John G. Richards, recently appointed a petroleum engineer in the Oil Loan division of the **Fort Worth National Bank,** formerly was a reserves and valuation engineer with The Texas Company. He joined Texaco in 1946 as engineering trainee, moving to Fort Worth and his previous position in 1951.

Oil Center Tool Company has announced these promotions and additions to the O-C-T organization: **Mike Hunter,** manager of the Casper, Wyo., district, has been promoted to chief sales engineer. Working out of the Houston office, he will cover all branches and systems on both sales and engineering. **Jack L. Simms,** formerly sales representative in Laurel, Miss., has been transferred to Casper to replace Hunter. **Henry E. Simonton, Jr.,** has been appointed to the O-C-T sales staff in Natchez, Miss. He has had several years general experience in the drilling and production branches of the oil industry.

Donald W. Lenzer, who has been appointed sales engineer in the Cincinnati territory by **Darling Valve & Manufacturing Company,** will provide sales engineering service in the area consisting of southern Ohio, southern Indiana, West Virginia and eastern Kentucky. He will specialize in Darling's broad metal products line of industrial valves, pipe line valves, water works valves and fire hydrants.

C. I. (Cliff) Little has been appointed manager of the erection department of **Kaiser Steel Corporation**—Fabricating division plant in Montebello, Calif. Prior to this new appointment, he was structural sales engineer. Little joined the sales staff of the Union Steel Company in 1945. He has had more than 35 years experience in the steel fabricating industry, both in the shops and sales department.

Byron Jackson Division of Borg-Warner Corporation announces the appointment of **C. Max Littlejohn** as head of their newly-expanded personnel department. Prior to joining BJ, he was with C. F. Braun Company as employment manager in the personnel department.

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LUXURIOUS STEEL YACHT

48 day cruise of the South Pacific with stop overs in Hawaii, Christmas Island, Tahiti, Acapulco. See Tahiti the Gem of the Pacific in all its grandeur. Four regular sailings yearly.

SPECIAL OLYMPIC GAME CRUISE

Departure from Los Angeles Oct. 1, 1956 for Melbourne, Australia — stopping in route: Honolulu, Samoa, Fiji, New Caledonia, and Sydney. Live aboard ship in Melbourne during games. On return home, stops are made at Auckland, New Zealand, Cook Island, and Tahiti. Return to Los Angeles Dec. 22. Make reservations now to assure seats at the Olympic Games — Limit 36 passengers.

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Excessive sand and sediment holds back your oil. For fast, easy clean out with fewer round trips and less downtime, use world famous Miller Sand Pumps.

SAND PUMP SIZES

O.D.—2½, 3, 3½, 4¼, 5, 5½, 7 In.
Lengths—20, 25, 30 ft.

Composite Catalog, Page 3433

Write for descriptive price list.

MILLER SAND PUMPS

Miller Sand Pump Co.

General Offices, Box 4516
Oklahoma City 9, Okla.

EXPORT OFFICES

30 Rockefeller Plaza
NEW YORK CITY 20, N. Y.

James C. Mabe

Thomas P. Wall

James C. Mabe, Jr., has been appointed manager of plant operations for the **Chicago Pneumatic Tool Company.** All manufacturing and engineering operations in the company's domestic plants at Utica, N. Y.; Franklin, Penn.; Fort Worth; and Garfield, N. J., will fall under his jurisdiction. He will headquarter at the head office in New York City. Mabe has been employed by the Douglas Aircraft Company, Inc., for the past 15 years. Since 1950 he has served as assistant factory manager at the Tulsa plant.

Thomas P. Wall, former manager of the Toronto branch office of Peacock Brothers, Ltd., is now general manager of **Rockwell Manufacturing Company of Canada, Ltd.,** a subsidiary of Rockwell Manufacturing Company, Pittsburgh. Wall assumes most of the duties of **W. W. Brydges** who recently retired as president of the subsidiary. Wall joined Peacock's engineering department in 1943, became assistant manager of the Paper division in 1949 and was named manager of the Toronto office in 1954.

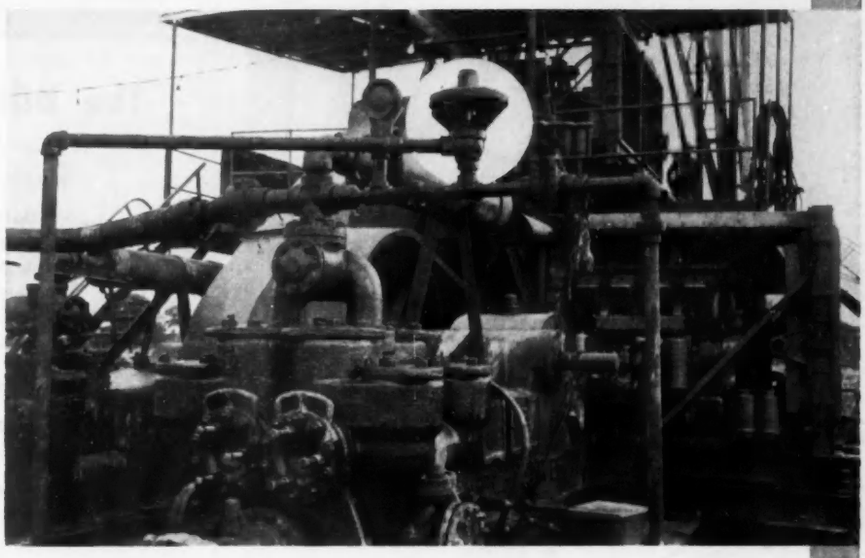
Lane-Wells recently announced the following personnel changes: **R. G. Hicks,** formerly division field engineer in the Gulf Coast division, is now in the Houston office acting as district operating engineer; **Russell A. Nelson,** division field engineer in Oklahoma City, was moved to Casper, Wyo., as district operating engineer; and **Vern D. Hilterbran** was transferred from his job as radioactivity well logging operator to Farmington, N. M., as station superintendent. In the Los Angeles office, **J. Shannon Baker** was promoted to assistant chief geophysical engineer. Succeeding him as acting division engineer, Pacific Coast division, is **Paul O'Haver.**

W. E. Jensen, new assistant chief engineer, **Byron Jackson (Oil Tools),** has been with BJ since 1951. He formerly was Mid-Continent field engineer in Houston.

McCullough Tool Company's D. J. Hall recently was appointed to a newly-created position of general sales manager for the Pacific and Mountain divisions. Joining McCullough in 1942 as a sales engineer, he has had wide experience in the drilling and producing divisions of the oil industry. **W. R. Wiley** was promoted to Pacific division sales manager to coordinate and supervise sales operations in the company's five California branches. A sales engineer with McCullough over six years, Wiley also spent eight years as sales engineer for Emsco Manufacturing Company. **Donald P. Hammon,** an operating engineer with the company since 1951, was promoted to manager of the Bakersfield, Calif., branch.

Only KINZBACH

Automatic Mud Relief Valves provide complete protection for personnel and equipment



Danger to personnel, damage to hole and equipment are ever-present hazards of excessive pressures. In each case the danger is cut to a minimum when you install Kinzbach Model 112 Relief Valves. They open automatically and instantly when the line pressure goes beyond safe limits—and when the pressure drops to a predetermined level, they close automatically.

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The fast and automatic action of the Model 112 Valve protects personnel from bursting hoses, couplings, and valves caused by runaway pressures; and protects equipment from overload damage. It also greatly reduces the possibility of hole damage by allowing the driller to keep pressure in the circulating system during a momentary block, such as might occur from spudding into bottom.

Modern drilling practices demand the complete protection offered by Kinzbach Model 112 Valves. Write today for complete literature, or order through your supply store. Available in 2" and 3" sizes, from 500 p.s.i. to 4500 p.s.i.

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(For more data on advertised products, use Readers' Service blue cards, last page this issue.)

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in sweet and condensate wells

For just a few cents a day you can minimize corrosion that costs you thousands of dollars annually. Regular addition of Rodine — an organic chemical developed by ACP — will retard corrosion, cut maintenance and replacement costs, help prevent loss of production.

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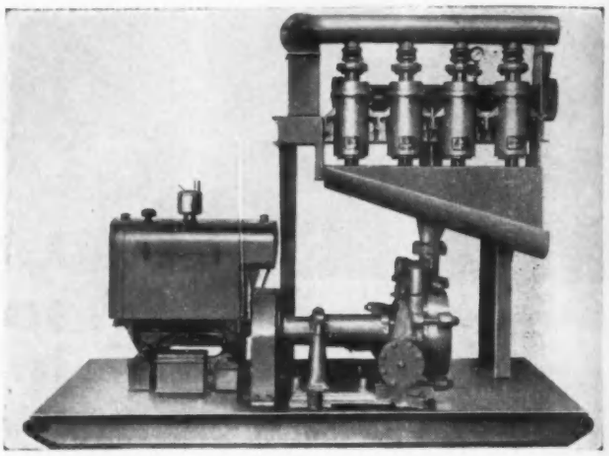

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- Up to 20% faster drilling
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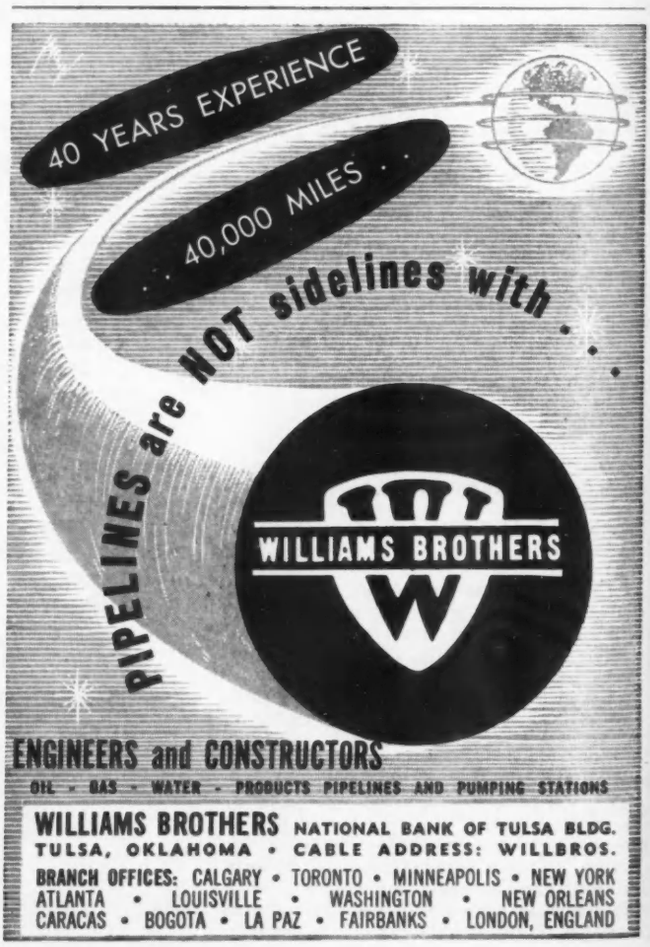

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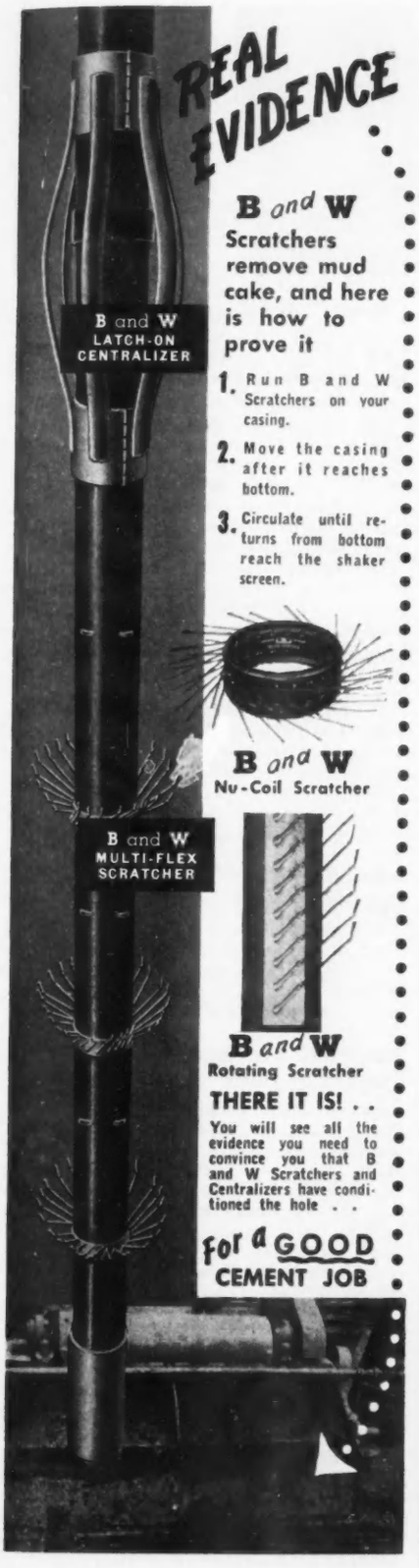
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B and W LATCH-ON CENTRALIZER
B and W Scratchers remove mud cake, and here is how to prove it
1. Run B and W Scratchers on your casing.
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B and W Nu-Coil Scratcher
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THERE IT IS! . .
You will see all the evidence you need to convince you that B and W Scratchers and Centralizers have conditioned the hole . .
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Roy C. Heacock

H. E. Lowrey

Axelson Manufacturing Company, Division of U. S. Industries, Inc., has announced the appointment of **Roy C. Heacock** as director of engineering. He will be in charge of engineering covering all of Axelson machine tool, petroleum equipment and aircraft products. Heacock, for the past eight years, has been with the Barber-Green Company as vice president and director of engineering and manufacturing.

The Continental Supply Company has announced the appointment of **H. E. (Ike) Lowrey** as manager of the Export division. Lowrey, who for the past three years has served as manager of Venezuelan operations, has his new headquarters in the New York City export office. He has been associated with Continental since 1935. **Julio Zumeta,** former export manager, has been named export sales manager. He will direct his attention to sales and engineering functions throughout the company's foreign operations. Replacing Lowrey in the Caracas office as manager of Venezuelan operations is **L. B. (Larry) Murray,** who for the past year has served as assistant in that position. In his new duties he will also be responsible for supervision of the company's business in Colombia, Peru and Ecuador.

Hydril Company has announced the transfer of **Robert B. Wallace** from its Los Angeles factory office to the sales office in Tulsa. Wallace began his career with Hydril Company working as a tread mill operator in the Rochester plant. In 1951 he joined the staff of the Los Angeles factory office, where he worked until the beginning of the current year. Since then, he has been on tour, visiting the Hydril sales offices around the country.

Oakite Products, Inc. have appointed three new technical service representatives. **John A. Price** has been assigned to serve accounts in the West Chicago area. **John C. Mullarkey,** formerly a contractor in Los Angeles, has been assigned to the Phoenix, Ariz., territory. **Charles L. Blasingame,** for six years a salesman for a paper firm, is now servicing Oakite accounts in Dayton, Ohio.

Lynn C. Edgar, recently appointed sales manager of **Tube-Kote, Inc.,** will supervise activities of all Tube-Kote sales engineers in a seven-state Southwestern area and personally will service Tube-Kote customers in the north Texas region. Besides these duties, Edgar will direct the bimonthly technical meetings instituted this year for key personnel. Edgar has been a sales engineer with the company seven years. Previously, he was with Humble Oil Company's Baytown Laboratory Testing division.

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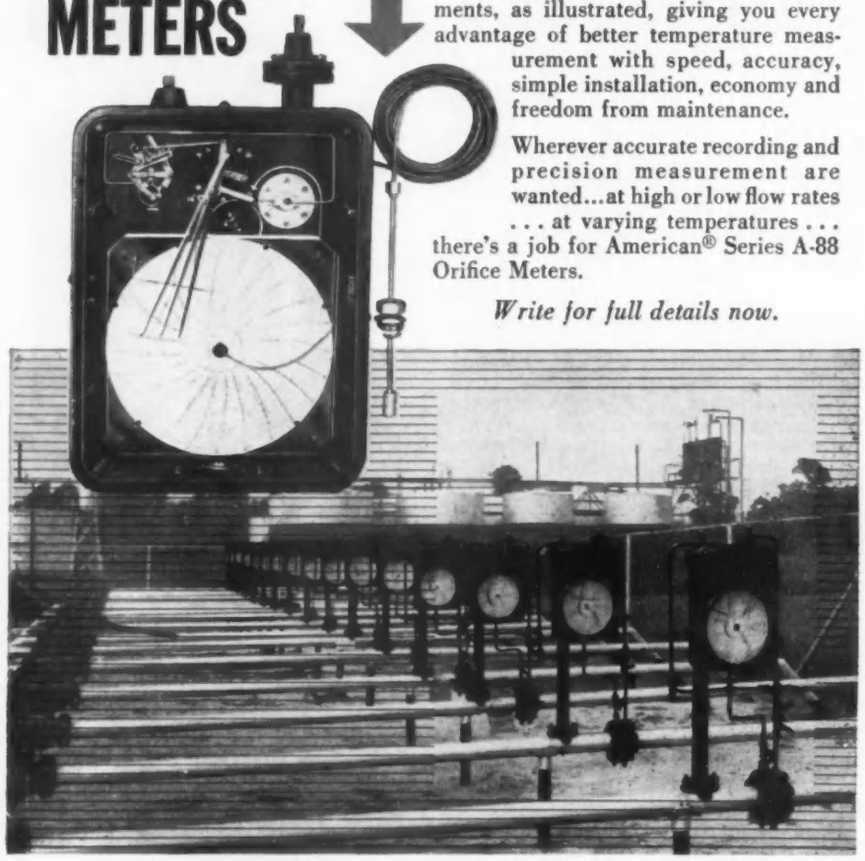

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William E. Brown

Bernard Jacknin

New Research Department Set Up by Western Company

The opening of a new research facility at Dallas to provide facilities for more fundamental research in the area of technical well servicing has been announced by The Western Company. It will extend the research and development work carried on by Western's engineering departments at Midland, Texas.

Staffed by research associates William E. Brown and Bernard Jacknin and their assistants, the new department will be headquarters for research activities in all areas of well servicing, including radioactivity logging, perforating, fracturing and acidizing.

Brown joined Western after five years with Gulf Research and Development Company where he served as senior scientist in the geological and geochemistry division. Jacknin previously was assistant to the director of engineering and development at Congoleum-Nairn, Incorporated.

New Lane-Wells Office Opened in Williston Area

Expanding activity in the Williston Basin has prompted the establishment of a new Lane-Wells Company truck station at Watford City, N. D. Elmer R. Thompson has been named operator in charge.

New Plant and Shop in Houston Planned by Hardy-Griffin

Hardy-Griffin Engineering Corporation, manufacturers of a new sealed tubing joint for the oil industry, recently announced plans for a new office and shop in the Lumpkin-Katy industrial district in Houston. Offices will be in a modern, all-brick building with over 4000 square feet of floor space. The shop buildings are to be of steel construction with more than 24,000 square feet of manufacturing space.

Chiksan Company Completes General Sales Conference

Chiksan Company, manufacturers of ball bearing swivel joints, recently concluded its second general sales conference at the main plant and home office at Brea, Calif. Attending the three-day session were over 70 salesmen and representatives from the U. S., Canada and South America. Included were the sales force of Well Equipment Manufacturing Corporation of Houston, a Chiksan division, and sales personnel from Chiksan Export Company, Brea, and Chiksan of Canada Ltd., Edmonton, Alberta, Chiksan subsidiaries.

New products introduced at the conference included a hydraulic marine loading arm, a self-contained all-metal unit for tanker loading and unloading of petroleum products; and the Chiksan Intelli-Giant, a hydraulically operated water monitor with many applications in the mining and construction industries as well as fire fighting.

Waukesha Sales & Service Completes Houston Addition

Continued expansion of Waukesha Sales & Service, Inc. operations necessitated a 5000-square foot addition to the company's headquarters in Houston. The new addition, recently completed, provides space for a number of offices, including executive offices and an employe cafeteria. Pictures of various Waukesha engine oil field installations were used to decorate the walls of the cafeteria.

Jones & Laughlin Supply Store Celebrates 50th Anniversary

A buffalo barbecue dinner at Woolaroc, Okla., and a tour of the famous Indian museum, were features of the 50th anniversary celebration of the establishment of Jones & Laughlin Steel Corporation's Supply division store at Bartlesville, Okla. The store has been at the same location since 1905 and was the first of the Frick-Reid Supply Company stores west of the Mississippi river. The store building housed the first general offices of the Western division and is the oldest supply store to be in continuous operation in the oil fields west of the Mississippi.

Sperry Products Acquires Western Inspection, Inc.

Acquisition of Western Inspection, Inc., of Midland, Texas, by Sperry Products, Inc., of Danbury, Conn., has been announced. Western Inspection will become Sperry Western, Inc., with offices remaining in Midland and Odessa, Texas, and in Lake Charles, Lafayette and New Orleans, La. Western's James H. Binford continues as president, with Sperry's R. B. Manning named vice president and treasurer, and D. W. Gordon, secretary and assistant treasurer.

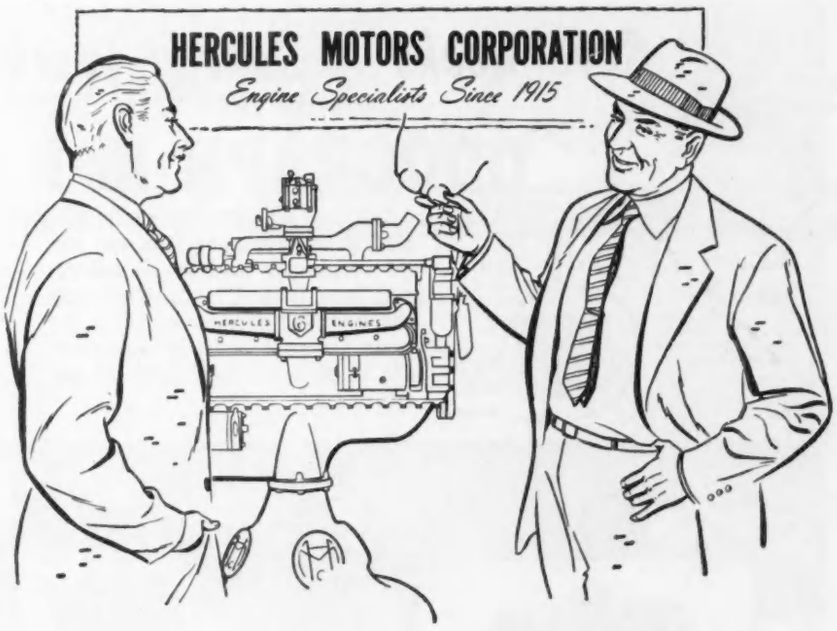
Rotary Sales Represents Edward In Alberta and Saskatchewan

Rotary Sales and Service Ltd. of Edmonton, Alberta, Canada, is now representing Edward Valves, Inc. in the Alberta and Saskatchewan, Canada, areas. Rotary Sales is headed by Orville L. Wooten, president, long associated with the petroleum industry and oil well drilling contractors in both the U. S. and Canada.

Lone Star Cement Expansion Increased to $57 Million

The board of directors of the Lone Star Cement Corporation has authorized enlargements at the company's Hudson, N. Y., Dallas and Houston, Texas, plants, and a new 2 million barrel plant to be built immediately near Lake Charles, La. This program, which involves a further expenditure of $35 million, is in addition to recently announced enlargement plans at five other Lone Star plants, and brings the cost of the present program to a total of $57 million, with an increase of 10.2 million barrels in cement capacity.

The new plant at Lake Charles will be built on a 350-acre site on the Calcasieu river at a cost of $14 million. To be completed in late 1956, the plant is being designed for shipment by both rail and water. The enlargement program at Hudson will increase capacity of that plant by 50 percent, or 1 million barrels. Annual productive capacity of the Dallas plant will be increased by 50 percent, or 1.4 million barrels, and the program at Houston will increase annual capacity of that plant by over 50 percent, or 1.1 million barrels.



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(For more data on advertised products, use Readers' Service blue cards, last page this issue.)

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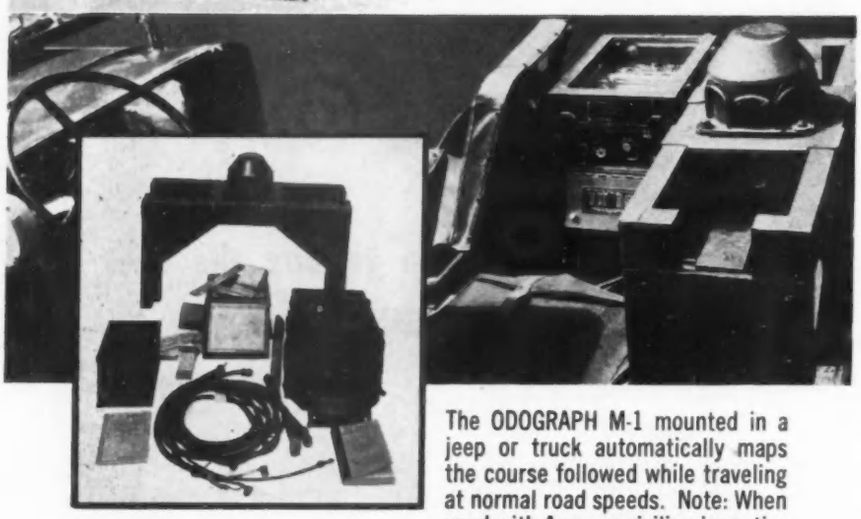

The ODOGRAPH M-1 mounted in a jeep or truck automatically maps the course followed while traveling at normal road speeds. Note: When used with Army or civilian jeep, tire size should be 6.00 x 16, however it can be used with any vehicle with speedometer drive of 1000 revolutions per mile.

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ODOGRAPH M-1 consists of three units: plotting unit, compass unit and power pack along with its electrical and flexible drive cables, spare parts, and accessories. Installed weight: 200 pounds.

MAP may be plotted on regular 8½ x 11 sheet or 10½ inch-wide 10 foot roll of 10 x 10 one-inch green grid paper contained in the plotting unit. A detailed map may also be placed in the plotting unit over which the course traveled is traced.

SCALE: Any scale from 1 to 20,000 to 1 to 500,000 on the Monroe Model and 1 to 20,000 to 1 to 800,000 on the IBM model may be plotted, giving a map area of from 2.40 x 3.15 miles to 60.1 x 79.40 miles on the Monroe or 2.40 x 3.18 to 96.16 x 127.04 on the IBM model.

The ODOGRAPH M-1 was designed and manufactured for U.S. Army Engineer Corps and has only recently been released for civilian application. The current manufacturer of these units sells them in excess of **$5,000.** The ODOGRAPH M-1 is now offered to you for the first time — as originally packaged — (specify type wanted, IBM or Monroe) at the low price of..... **$395.00**

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Grant Oil Tool Company Opens New Sales and Service Branch

Grant Oil Tool Company announces the opening of a sales and service branch in the Texas Gulf Coast region to service the Houston-Gulf Coast area. Located in Houston, the branch will stock the complete line of Grant tools.

George T. Carter

Head of the new addition to Grant service facilities is George T. Carter, branch manager, who returns to Houston in his new position after three years as field service and sales representative. Kenneth Peek has been appointed head of field sales and office at the new branch.

New Home Office Building Occupied by United Core

United Core, Inc. has moved into its new home office building in Houston. Facilities include offices, an accounting department, production laboratory where cores are analyzed, a research laboratory and printing and drafting rooms.

Back of the main building is a smaller structure where United Core manufactures its own electronic equipment for standardization and accuracy of testing. W. A. Boatman, Jr., is president of United, and B. F. Winborn, Jr., is vice president.

Adair, Thrash Are Partners In New Macco Distributorship

Macco Oil Tool Company announces formation of a new distributorship in south Louisiana and Mississippi. Partners in the Delta division, known as Macco Gas Lift of the Mississippi Delta, are William B. Adair and Purvis J. Thrash. They will be located in Houma, La., for engineering, sales and service of gas lift and associated equipment.

Adair, who started with Macco Oil Tool in 1953 as sales engineer, has been chief engineer of the firm for a year. Thrash has been a distributor for Macco in Louisiana two years.

Unit Process to Represent Vanton in Northwest, Alaska

Appointment of Unit Process Company, Seattle, as sales representatives for Vanton Pump & Equipment Corporation, was announced recently. Territory to be covered includes Idaho, Montana, Washington, Oregon and Alaska.

With more than 20 years of experience in chemical engineering, Raymond Loesby, who heads up Unit Process Company, will service users of the Vanton pump which is designed to handle corrosive and hazardous liquids.

Larkin Packer Company Builds Headquarters Plant in Texas

Construction is under way on the new plant and general office headquarters for Larkin Packer Company, Inc. in Waxahachie and is expected to be completed before the end of the year.

The new building, which provides for more than a 40 percent expansion of the company's present facilities in St. Louis, covers approximately 70,000 square feet and occupies a 28-acre site in Waxahachie.

New Waukesha Branch to Handle Engine Sales in Abilene Area

Waukesha Sales & Service, Inc. has opened a new branch in Abilene, Texas, to serve users of Waukesha engines in that area. The branch carries a complete line of engines and replacement parts and operates a 24-hour-a-day repair service. Cecil Hodby is manager.

Mountain Iron and Supply Establishes Dallas Office

Announcement was made recently that Mountain Iron and Supply Company has expanded its oil field service and supply facilities by establishing a sales office in Dallas, Texas. Frank Northway, formerly with Humphrey Oil Corporation, has been appointed sales manager of the new Texas district.

SIE Proposes Merger With Dresser Industries

Southwestern Industrial Electronics Company of Houston, manufacturer of electronic equipment having particular application in the petroleum industry, has completed negotiations for a merger with Dresser Industries, Inc., one of the largest suppliers of oil, gas, chemical equipment and technical services.

SIE was organized in 1945 as a partnership between Keith R. Beeman, president, and Richard H. Parker, now executive vice president of the firm, to build transformers and electronic instruments for the geophysical industry. The company also manufactures auxiliary equipment such as truck instrument bodies and all related devices required to outfit a seismograph field party.

Present SIE management will continue to operate the company after the merger which still must be confirmed by the boards of directors of both firms.

New Spudder Distributor Named by Bucyrus-Erie

Cable Tool Supply Company of Princeton, Ind., has been appointed distributor of Bucyrus-Erie Company's complete line of spudders in portions of Illinois, Indiana, Kentucky and Tennessee.

Henry C. Neely, for many years a Bucyrus-Erie district drill sales representative in Evansville, Ind., will be assisted in the new concern by William J. Wheeler, who also has had extensive experience in oil field work.

Dravo Corporation Begins $400,000 Research Center

Ground has been broken to begin a $400,000 building program in Pittsburgh for centralized research operations of Dravo Corporation. The first shovel of dirt was turned by Alex W. Dann, retired executive vice president of Dravo who pioneered the firm's research activities. Dann retired June 1 after 42 years with the company.

The research center will be a T-shaped masonry structure on a two-acre plot adjacent to the company's main plant. First phase will be construction of the leg of the T, a shop building 44 feet wide, 104 feet long and 25 feet high. It will be completed by the end of the year.

The remainder of the building program —6500 square feet of offices, reception room and additional laboratories—will be completed in two stages within two years.

Head of Dravo's Research and Development department is W. L. Newhall, who has been with the company 30 years.

WORLD OIL'S Trading Post CLASSIFIED ADVERTISING

RATES: Regular Classified (undisplayed) set in this size type: 12 cents per word. Minimum charge, $3. Blind box address in our care counts six words. Replies forwarded without charge. **Situation wanted ads,** 6 cents per word. **Display ads,** set in suitably larger type with ruled border, $12 per column inch; situation wanted display ads, $6 per column inch. Ten percent discount for two or more insertions of same copy in consecutive issues. **All classified ads payable in advance. COPY DEADLINE:** 17th of month preceding date of issue. Send copy and checks to: **Trading Post Section, World Oil, P. O. Box 2608, Houston, Texas.**

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■ NATIONAL T-12 rig on 32′ Tandem Trailer, 145 HP Motor, complete except drill pipe. First class condition, approx. 8 months old. Box 79-W, WORLD OIL, Houston, Texas.

■ ELI DRILL M6D-164-D on 1948 Ford. New motor, good rubber. 22′ Mast, 13′ Kelley. 4½ x 5 GD Pump, 150′ Rod, slush pit and bit subs. SeisDrill Inc., 515 Thompson Bldg., Tulsa, Oklahoma.

■ CABLE TOOLS FOR SALE. Good condition. Wichita 61, Fort Worth Super "D." Both Rigs with masts, motors, light plants, dog house, etc. Good iron from 15″-5½″. W. H. McGarr Industries, P. O. Box 826, Coleman, Texas.

FOR SALE: Premises of Dunlap & Graham at 2450 Cerritos Avenue, Long Beach, California. Ideal for Drilling Contractor, Oil Well Supply Yard, Etc. Price $35,000.00, or might consider long term lease.

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■ SEISMOGRAPH COMPUTER. Must have experience and free to travel. Box 78-W, WORLD OIL, Houston, Texas.

■ GEOPHYSICIST: A major contracting geophysical company has an opening for a geophysicist to be in charge of its foreign department. Must have 10 years experience, the majority in foreign service, a college education, and an ambition to make new acquaintances. Write details of age, education, experience, availability for travel, etc., to Box 75-W, World Oil, Houston, Texas. Our employees know of this ad.

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A large crude oil pipe line company, operating within Oklahoma, has openings for Engineering graduates. Diversified, interesting and permanent employment with advancement opportunities. Experience not essential, but a reasonable knowledge of hydraulics, office and field work in the design of crude oil pipe lines and pump stations is desirable. Submit resume and salary requirements with recent snapshot to WORLD OIL, Box 80-W, Houston, Texas.

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■ METALLURGIST. Executive level, BS degree Colorado School of Mines, 22 years experience in metallurgical supervision, technical development, research with nationally recognized business firms. Constructed, equipped, managed laboratory and staff of over 20 for four years. Experience includes close liaison with Army, Navy, AEC since 1941. Recognized inventor, author of several technical articles and books. Married, age 44, prefer Houston location and work in oilfield equipment manufacture. Complete resume, references available. Box 77-W, WORLD OIL, Houston, Texas.

■ LANDMAN, degree in geology, desires position with an independent working out of Houston. Box 76-W, WORLD OIL, Houston, Texas.

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  By ZABA & DOHERTY
  price $11.00
- **Rotary Drilling Handbook**
  By J. E. BRANTLEY
  price $10.00
- **Acidizing Handbook**
  By BENSON M. KINGSTON
  price $3.50
- **Basic Oil Geology**
  By W. W. PORTER III
  price $4.00
- **Practical Accounting for Oil Producers**
  By ROBERT M. PITCHER
  price $9.50
- **Petroleum Dictionary**
  By HOLLIS P. PORTER (Deceased)
  price $6.00
- **Oil Property Valuation**
  By PAUL PAINE — price $5.50

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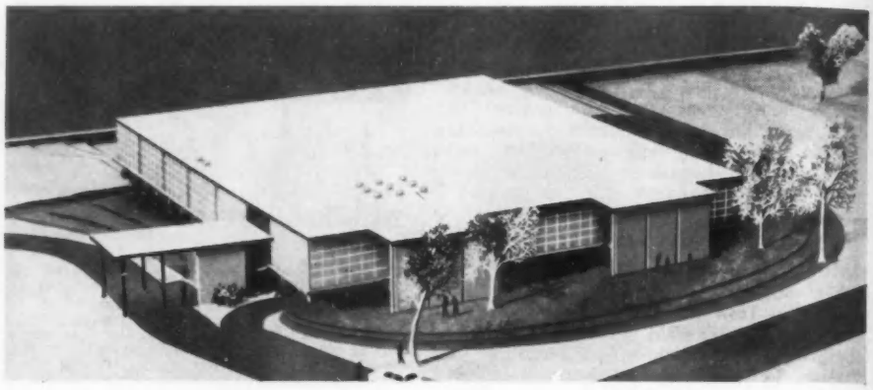

HTL Starts New Plan Construction

A five-acre tract on Houston's Buffalo Speedway is the site for the new main plant of Houston Technical Laboratories, Texas Instruments geophysical instrumentation subsidiary. Now under construction, the modern building contains 40,000 square feet designed to house the research, design and manufacturing operations of the company. A geophysical instrumentation museum will be located in the lobby area.

Petroleum Electric Power Group Elects Officers and Directors

Officers for 1956, elected at the 27th annual meeting of the Petroleum Electric Power Association, include Fred B. Clark, Arkansas Power & Electric Company, president; F. R. Woerner, Texas Electric Service Company, vice president; and J. F. Maddox, New Mexico Electric Service Company, secretary-treasurer.

Directors elected were W. L. Thomson, Gulf States Utilities; U. H. Ohrman, Texas Power & Light Company; Harvey Cherry, Houston Lighting & Power Company; and Clark, Woerner and Maddox. Delegates chose Corpus Christi, Texas, as the 1956 meeting city.

Walworth Company Purchases Texas Pipe Fabricating Firm

Purchase of the assets and business of the Southwest Fabricating & Welding Company, Houston, a pipe fabricating company, by the Walworth Company has been announced. Southwest Fabricating, which supplies markets throughout the world in the oil, chemical, petrochemical and natural gas fields, will be operated as a subsidiary of Walworth, retaining present management and employes and continuing present policy.

Rockwell Manufacturing Plans New Plant in California

Rockwell Manufacturing Company soon will begin construction of a 100,000 square-foot warehouse, assembly and repair plant at Porterville, Calif. Expected to be completed by early 1956, it will cost approximately $1 million.

A one-story concrete-and-tile structure on a 32-acre plot, the plant will be used for assembly, repair and warehousing of Rockwell meter and valve products for West Coast distribution, and for warehousing of Rockwell-built Delta power tools for western industries and home workshops.

Brewster Celebrates 45th Birthday

More than 1000 U. S. oilmen helped Brewster Company celebrate its 45th birthday as a manufacturer of drilling equipment at an old-fashioned Louisiana shrimp boil at the company's plant at Shreveport. As an added attraction, the men took turns operating a deep drilling Brewster N-95 drawworks, fully rigged up for the occasion. Mounted on a high substructure, the new N-95 on display was purchased by Jet Drilling Company of Denver through the Bovaird Supply Company.

New Books, Maps and Movies

OIL AND PETROLEUM YEAR BOOK, 1955, compiled by Walter E. Skinner, 20 Copthall Avenue, London, E.C.2. $5 post free abroad.

The 1955 edition of this standard reference work contains complete and up-to-date information on 970 companies operating in all parts of the world and covering all branches of the oil industry. A list of names and address of 663 managers and engineers and the companies with which they are connected also are included. The material covers principal British, American, Canadian and foreign companies.

Particulars of each company include names of directors and other officials, description of business, where operating, crude oil production, refinery runs, details of capital, dividends and financial results.

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OIL AND GAS PIPE LINES IN OHIO, Revised Edition, 1955, Division of Geological Survey, The Ohio State University, Columbus 10, Ohio. $1.50 for folded map.

This new map, in five colors, shows operations of the oil and gas industry in Ohio. The gas portion contains names of utility companies, size, number and ownership of transmission lines, number of consumers, points of distribution, compressor stations, underground gas storage areas and gas lines entering the state. The oil section includes location of refineries, their capacity, principal refined products, crude and products transmission lines, direction of flow, compressor stations and large storage terminals.

•

MINERALS MAP, The Oklahoma Geological Survey, Norman, Oklahoma. 75 Cents.

The Oklahoma Geological Survey has released a new minerals map of Oklahoma in color. Included are major pipe line systems and locations of industrial plants, by companies, with comments on types and grades of minerals.

•

THE 1956 OIL DIRECTORIES, Midwest Oil Register, Drawer 7248, Tulsa.

Listing key operating and home office personnel, companies, partnerships, independent producers, drilling contractors and the type drilling equipment owned, the revised directories for 1956 now available are:

Producing and Drilling: Texas, $16, Oklahoma, $10; California, $10; Kansas, $6; Michigan-Illinois-Indiana-Kentucky, $10; Louisiana-Arkansas-Mississippi-Georgia-Florida, $6; Rocky Mountain Region and New Mexico, $7.

Refining, Petrochemical and Natural Gas Processing Plants of the World, $15.

Pipe Line and Pipe Line Contractors, $12.

Oil Directory of Companies Outside the U. S. and Canada, $10.

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Directory of Geophysical and Oil Companies Who Use Geophysical Service, $10.

Directory of Oil Well Supply Companies, $18.

Oil Directory of Houston, Texas, $10.

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Old World Charm

The proverbial Texan, with all his forthright speech, is unusually gallant about the fair sex. At a barbecue, one old codger prepared to dig into a bit of succulent goat when someone joggled his elbow and knocked his plate to the ground.

He blasted out with a roar that shook the park grounds. "Hawg! You want all the room they is?"

Then seeing that he was barking at a woman, off came the old Stetson and in a gentler voice, he added:

"Lady hawg, that is, ma'am."

Too Careful

At a party recently a professor felt that he had partaken rather freely of the champagne and determined to be careful and avoid showing any of the usual signs of tipsiness.

When they arose from the table, someone suggested that the hostess exhibit "the latest edition of her family." She agreed and presently the nurse appeared with a dainty pink basket containing twins. The prof steadied himself, gazed into the basket and said: "What a beautiful baby."

Silly Question

The small boy had fallen into the stream, but had been rescued.

"How did you come to fall in?" asked a bystander.

"I didn't come to fall in," the boy explained; "I came to fish."

From the Start

An elderly couple had been married 60 years. The husband was asked if they ever quarreled. He replied no. When asked the secret of such a happy marriage he answered, "Right after we were married we went to the mountains for our honeymoon. On the way up her horse stumbled. I looked at her horse and said, 'that's once.' We continued and her horse stumbled again. I looked at the horse and said, 'that's twice.' We went a little further and the horse stumbled again, and I said, 'that's three times.' I got off my horse, walked to hers and shot the horse.

"I put my wife on my horse, I got on and we started on up the mountain. She began to chew me out for shooting the poor horse. I listened carefully until she finished and then turned to her and said, 'that's once'."

Private Income

Two friends met on Main Street. "Hello," said the first, "you look nice and tanned. Just get back from Florida?"

"Yes," answered the second, "and did we have a great time! For $40 a day we stayed at the Roney Plasma."

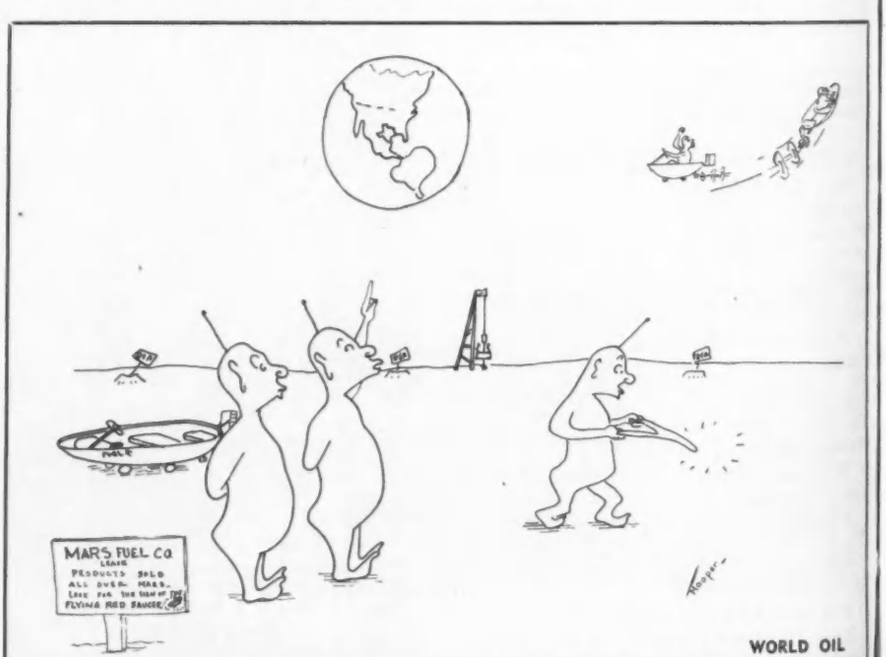
"You mean Roney Plaza, plasma is blood."

"Well," countered the first, "is $40 a day barley water?"

Bells?

The second floor tenant called the party below and shouted, "If you don't stop playing that blasted saxaphone, I'll go crazy."

"I guess it's too late," came the reply. "I stopped an hour ago."



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McCullough M-3 Guns Gain 760 B/D

Previous Attempt Failed To Get Penetration

Powerful McCullough M-3 Guns firing improved Ogival Bullets again proved their superior penetrating power in a recent job in this Texas well.

The well had first been perforated by another service company, but the operator was unable to break the formation down under 3500 pounds pump pressure.

Depth of operation was 9800'. 5½" O.D., 17 lb. casing had been cemented through the pay zone.

McCullough 4¼" O.D., 30-shot M-3 Perforators fired 84 improved ½" Ogival Bullets in the same interval previously perforated. The formation broke down at 1200 pounds pump pressure. After treating, the well made 760 barrels of oil per day—the best well in the field.

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M-3 Guns Shoot 400 Holes in 73° Angle Well in Two Runs

Unusual Perforating Job Could Only Be Accomplished By Simultaneous Firing, Deep Penetrating McCullough M-3 Bullet Perforators

While unusual jobs such as this occur only infrequently, they serve to demonstrate the ability of McCullough Perforating Services to accomplish the tough jobs with the same speed, economy and satisfaction that characterize ordinary operations.

This well was directionally drilled from an onshore location out under the ocean bed. Due to the high degree angle of the well (73°) it was impossible to perforate by regular electric wire line methods.

8⅝" O.D., 36 lb. casing had been cemented in 12¼" hole. The interval to be perforated was from 6696' to 6796'.

Ten 4¼" O.D., 20-shot McCullough M-3 Guns (50') were screwed together and run in on 4½" F. H. drill pipe. A swab cup was arranged on a 1⅜" O.D. probe, attached to the electric wire line and pumped down the drill pipe until it contacted a firing sub attached to the top of the guns.

Two sets of M-3 Guns of the above length were run, firing 400 ½" improved Ogival Bullets in the 100' zone. The entire job took only 26 hours to complete which included two round trips with the drill pipe and two runs with the probe. No trouble, no delay was experienced. The job was satisfactory in every respect.

Only McCullough M-3 Guns, firing all shots at one time, could successfully complete this unusual job. In addition, deep penetration through heavy casing cemented in large diameter hole was assured by the extra power of M-3 Guns firing improved Ogival Bullets—hardest shooting bullet perforators in the world.

Literature Available on McCullough M-3 Bullet Perforators

1. **Four-page illustrated bulletin, No. 203, gives advantages, characteristics, etc. of M-3 Bullet Perforators and improved Ogival Bullets.**
2. **Sixteen-page pocket brochure tells benefits of M-3 Perforators, supplemented by actual job reports.**

Write to McCullough Tool Company, 5820 S. Alameda St., Los Angeles 58, Calif.

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First Class

Two New York French poodles, to their discomfort, found themselves in the presence of a mongrel mutt, and were trying to ignore him. One poodle asked the other, "What's your name?" "My name is Fifi—spelled F-I-F-I," was the reply. "My name is Mimi—spelled M-I-M-I," said the other poodle.

Not to be outdone, the mutt said, "Well, my name is Fido—spelled P-H-I-D-E-A-U-X."

I Told You!

"When I go to bed at night I always keep seeing red and green lights in front of my eyes."

"Have you seen an optometrist?"

"No, only red and green lights."

Business Before Pleasure

A proud father had given his small daughter a splendidly equipped doll house for her birthday. On his return after a week's absence, he asked her how she liked it.

"It's very nice, Daddy," she said.

"But where is it?" he inquired, not seeing it anywhere in the house.

Came the reply: "Oh, I've rented it furnished to Mary for 10 cents a week."

To Each His Own

A story is making the rounds in Alabama about the dyed-in-the-wool Dixiecrat who attended a meeting at which candidates for delegate to the national convention outlined their views.

When all had spoken, a friend asked, "Well, what do you think now, Lem?"

"Think?" exclaimed the Dixiecrat. "I didn't come here to think. I came here to holler!"

Just A Chance

A little boy was in the habit of coming to the table with a dirty face and was constantly being sent back to the bathroom to wash before being allowed to eat with the rest of the family. One time, his mother, nearly losing her patience, said:

"Junior, why do you persist in coming to the table without washing? You know I always send you back."

"Well," was the meek reply, "once you forgot."

Some Warning

"Hey, you'd better be more careful!" shoufed the motorist to the careless pedestrian whom he had just knocked down.

"Great gosh!" sighed the prone victim, "don't tell me you're coming back!"

Mountain Do

A hillbilly came to town carrying a jug of spirits in one hand and a shotgun in the other. He stopped a man on the street, saying—"Here friend, take a drink outa my jug."

The man protested he didn't drink.

"The hillbilly leveled his shotgun at the stranger and said —"drink."

The stranger drank then he shuddered, shook, shivered and coughed. "Gad, that's awful stuff."

"Ain't it?" said the hillbilly. "Now hold the gun on me while I take a gulp."

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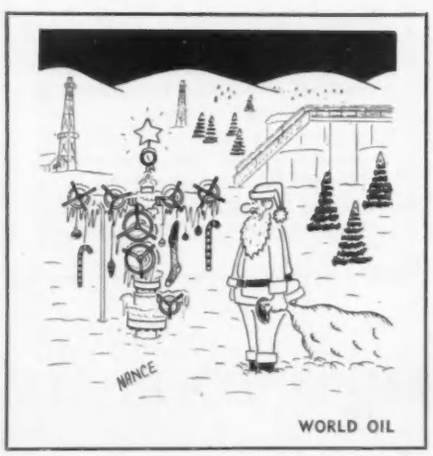

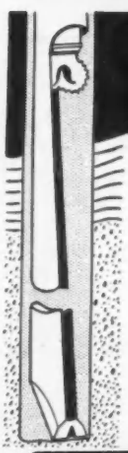
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Widespread duplex hooks for easy elevator operation.

Capacities 25 to 100 tons.

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Turn About

A young lady stalled her car at a traffic light. She stamped on the starter, tried again, choked her engine while behind her an impatient citizen honked his horn steadily. Finally, she got out and walked back. "I'm awfully sorry, but I can't start my car," she told the driver of the other car. "If you'll go there and start it for me, I'll stay here and lean on your horn."

Some Dish!

"And after Goldilocks ate the porridge," read the baby sitter, "she went upstairs and saw three beds . . ."

"Jeepers!" interrupted Junior, "I'll bet the porridge had been spiked!"

Confirmation

A minister received a "call" from a much larger church in another city. It was a much bigger and more remunerative pastorate but he replied to the offer by saying that he would prayerfully consider the matter and give his decision in a few days. A short time later his little son was asked if his father had come to any decision.

"I don't know," was the lad's answer. "Papa is still praying, but Mama has all the things nearly packed."

Hold On!

The hard old engineer had braked his engine alongside the water tank and was instructing his new fireman. Somehow the new man got his foot caught in the spout chain and stepped right into the tank.

As he thrashed wildly the engineer calmly watched with a jaundiced eye.

"Just let the water run in, Sonny," he drawled. "No need to stamp the stuff down."

Even

A filling station attendant approached the owner and said: "Boss, your doctor's in here with a flat tire."

Station Owner: "Good! Diagnose the trouble as puncture wounds resulting in a prolapsed perimeter. Prescribe plastic surgery followed by a complete treatment with inflatus windus. Then charge him accordingly!"

"Guess Block 18 rig is moving on!"

Early Riser

Professor, to early class: "Order, please."

A drowsy voice from the rear of the room: "Two more beers."

Mean Face

"I couldn't serve as a juror, judge. One look at that fellow convinces me he's guilty."

"Quiet, that's the district attorney."

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What's New In Equipment

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Seismometer

Houston Technical Laboratories' new miniature velocity type seismometer which weighs less than a pound, is designed especially for multiple array use in land exploration. Employing both electromagnetic and fluid Dow Corning Type 200 damping, the seismometer has undetectable spurious response and high lateral stability up to 500 cps. Tested from —60° F. to 150° F. with neglible change in damping, it is ideally suited to high frequency, high resolution operations.

It is 1⅞ inches high, 1½ inches in diameter and weighs only 11 ounces. A brass base cap and stainless steel case with a solder seal assures complete protection of the internal element under the most rugged operational conditions.

A special feature minimizing wind noise pick-up is the locating of the takeout connection at the bottom of the instrument. The takeout normally supplied is 18-inch, 400 pound test, wire rope lay cable with a molded reinforcement. Units also are available with a two-hole cap for through-cable connection.

For more data, circle **No. E1** on Readers' Service Card, last page this issue.

Oiling Device

The problem of how to flood dies with cutting oil while threading pipe with hand die stocks, by muscle or power drive, is said to be solved by a new product announced by The Ridge Tool Company. Called the Ridgoilr (Ridge Oiler), it is portable, consists of a removable 15-inch wide chip pan in an oil reservoir with carrying bail, from which a screened hose connects with a hand operated oil pump gun. Placed under the work, the device catches oil, chips and cut-offs, keeping floors clean, while allowing an endless stream of clean oil on dies, cooling and protecting them. More than 95 percent of the oil is saved and used again.

For more data, circle **No. E2** on Readers' Service Card, last page this issue.

Turbocharged Diesel Engines

Production of two new turbocharged diesel engines, the Cummins NTO-6 and NT-6 Turbodiesels, is announced by Cummins Engine Company, Inc. Now available for automotive, off-highway, industrial and marine applications, the NTO-6 Cummins Turbodiesel develops 262 horsepower while the NT-6 Cummins Turbodiesel is rated at 250 horsepower. Maximum speed of both is 2100 rpm.

Essentially of the same design as the 200 horsepower NH-600 Cummins Disel, both the new turbodiesels receive their increased power with the addition of a turbocharger.

Both the NTO-6 and NT-6 are six cylinder, 4-cycle engines with a bore and stroke of 5⅛ by 6 inches and a piston displacement of 743 cubic inches. Compression ratio for both engines is 15.5 to 1, while the weight for both is 2546 pounds.

(This item supplements Cummins Engine Company, Inc. data on Pages 1353-1372 of the Composite Catalog, 21st Edition.)

For more data, circle **No. E3** on Readers' Service Card, last page this issue.

Big-Inch Couplings

New 42-inch OD, ASA 600 Unibolt couplings equipped with blanking plugs, manufactured by Thornhill Craver Company for Joe Stine, Inc., will be used instead of blind flanges to close the ends of hydraulic cylinders being fabricated by Stine for an offshore drilling platform.

The coupling with blanking plug weighs approximately 40 percent less than a flanged closure of the same ASA 600 rating. The blanking plug itself weighs only 1454 pounds as compared to 3280 pounds for the blind flange of a conventional flanged closure. The Unibolt closure requires three bolts; the flanged closure requires 48 bolts which weigh a total of 717 pounds.

(This item supplements Thornhill-Craver Company, Inc., Unibolt Division, data on Pages 4893-4920 of the Composite Catalog, 21st Edition.)

For more data, circle **No. E4** on Readers' Service Card, last page this issue.

Diesel Tractor

Allis-Chalmers Manufacturing Company recently announced production of their HD-6 diesel-powered crawler tractor. Weighing 12,400 pounds, the tractor is powered by the new Allis-Chalmers HD-344 diesel engine that develops 47 net flywheel horsepower, 55 horsepower at the belt, and 45 horsepower at drawbar. It is equipped with a hydraulically controlled bulldozer.

(This item supplements Allis-Chalmers Manufacturing Company data on Pages 896-901 of the Composite Catalog, 21st Edition.)

For more data, circle **No. E5** on Readers' Service Card, last page this issue.

Diesel Trucks

Nine diesel-powered International Trucks have been added to the highly specialized heavy heavy-duty line manufactured by the motor truck division of International Harvester Company.

The new diesel-powered models include four in the four-wheel International RD-220-H series, three in the six-wheel RDF-210-H series, and two six-wheel off-highway models—the RDF-214-H and RDF-230-H. They range in gross vehicle weight from 26,000 to 60,000 pounds.

With integration of these four new series into the Fort Wayne-produced line of trucks, International now has a series of diesel-powered trucks which can be tailored to practically any operation.

Standard power plant in the new models is the HRB-600 Cummins engine, developing 165 horsepower. Clutch is 14-inch, two-plate, and transmission is five-speed direct-in-fifth. Bumper to center of front axle dimension has been increased by approximately 12 inches to accommodate engine length, while AC, CA, and wheelbase dimensions remain the same as for comparable gasoline-powered models.

Numerous diesel engine, wheelbase, transmission, rear axle, brake, chassis, and electrical equipment options are available.

(This item supplements International Harvester Company data on Pages 2605-2608 of the Composite Catalog, 21st Edition.)

For more data, circle **No. E6** on Readers' Service Card, last page this issue.

Save time! Keep informed! Circle numbers on Readers' Service Cards, last page this issue

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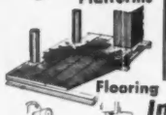

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- ROLLER WIRE LINE GUIDES on hardened steel pins.
- SIDE OPENINGS for inserting packing while line is in the hole.
- PACKING IS SELF-CENTERING; compression screws need not be evenly adjusted.

Export: R. S. STOKVIS & SONS
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KING OIL TOOLS

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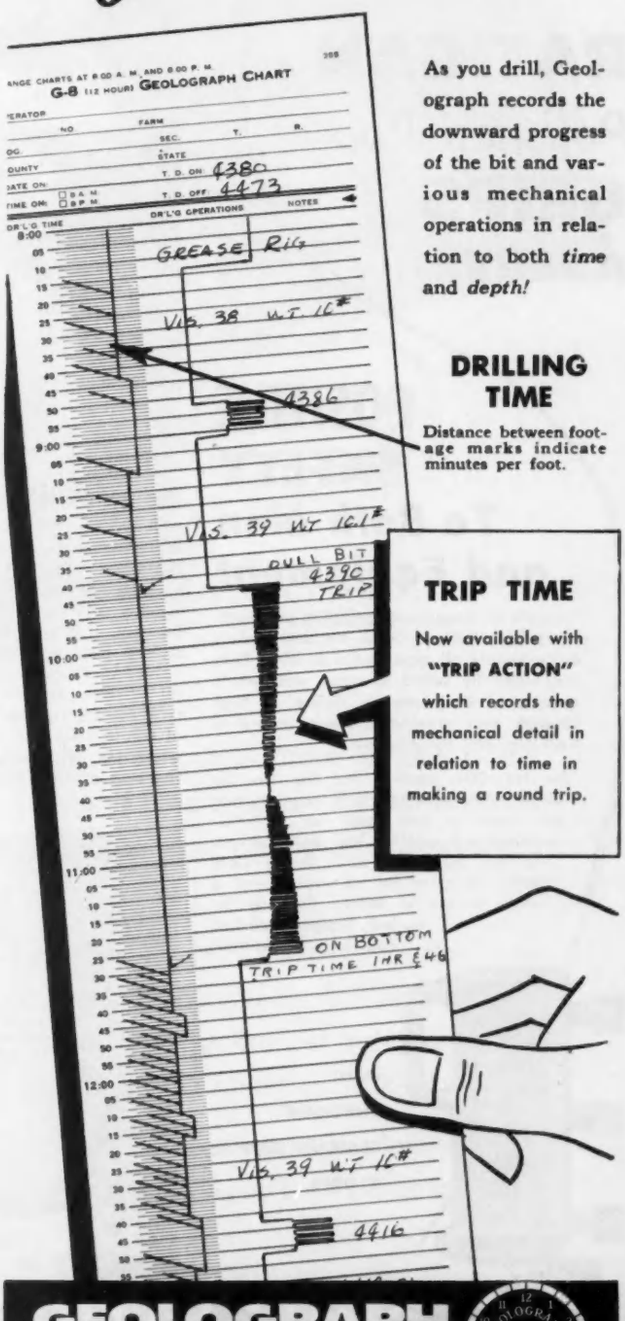

As you drill, Geolograph records the downward progress of the bit and various mechanical operations in relation to both *time* and *depth!*

DRILLING TIME

Distance between footage marks indicate minutes per foot.

TRIP TIME

Now available with **"TRIP ACTION"** which records the mechanical detail in relation to time in making a round trip.

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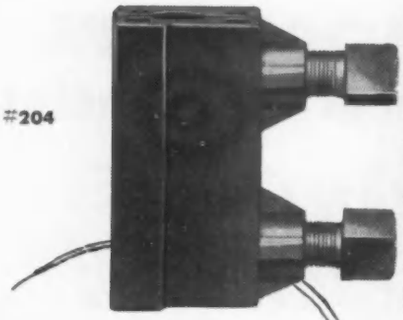

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GRIPS
ASSURE

POSITIVE SAFETY
To Both Men and Equipment

Capable of exceptional gripping and holding power, Ratigan Grips are designed to accommodate all type pumping units. They are especially suited to those units which require a short, narrow devise of high capacity and provide maximum safety to both men and equipment.

The No. 204 (above) and the No. 50 (below) both have 53,000 lb. capacity and are made in two sizes: for 1⅛"-1¼" polished rod; and for 1½" polished rod. The No. 50 is an extra heavy duty model, designed for all depths with a large margin of safety. Properly installed, Ratigan Polished Rod Grips Never Fail!

#50

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1213 Santa Fe Ave., Los Angeles 21
Export: National Supply Co., Inc., Export Div.
600 Fifth Ave., New York 20, N.Y.

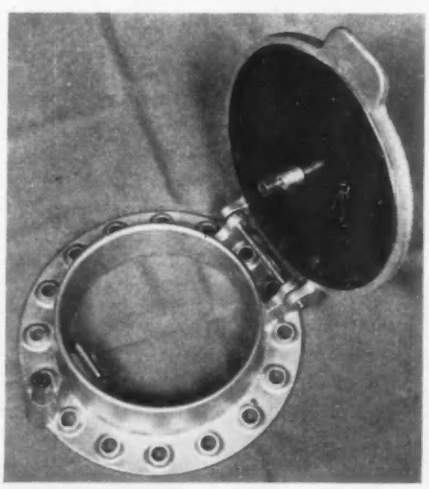
PRODUCTION

Drain Control Device

A new drain control device, the Oil Miser, has been introduced by Southland Plastic Products Company. It consists of a transparent bulb with interior baffle which allows visual inspection of fluid passing through bleeder lines. When installed just downstream from the bleeder valve, bleeding can be stopped as soon as oil appears in the bulb. This visual control results in the saving of many barrels of oil in that the bleeding can be stopped when the oil reaches the valve rather than the end of the bleeder line. Also, bleeding can be accomplished in much less time than with older methods.

The control device measures 3½ inches in length and is male threaded to fit any standard 2-inch tee. The unit is designed to operate with pressures to 100 psi at 100° F. It is not recommended for use with fluid temperatures in excess of 130° F. The unit is baffled for positive operation at any position 360 degrees around the pipe line.

For more data, circle **No. E7** on Readers' Service Card, last page this issue.



Thief Hatch Valve

Enardo Manufacturing Company has announced production of a dead weight thief hatch valve, an 8-inch round deadweight hatch with the pressure and vacuum relief valves built into one valve. This is a diaphragm valve featuring the same principle of pressure and vacuum relief as the company's series 770 and 770-BP spring loaded valves. The valve can be adapted to 3 or 4-ounce pressure relief settings by the addition of weights placed on the cover.

The valve is constructed of cast "Meehanite" iron base and cover, no basin, with thief and thermometer hook on base, and Neoprene cover stop. The standard 2-ounce valve weighs approximately 21 pounds.

(This item supplements Enardo Manufacturing Company data on Pages 1602-1605 of the Composite Catalog, 21st Edition.)

For more data, circle **No. E8** on Readers' Service Card, last page this issue.

Gas Dehydrator

Black, Sivalls & Bryson, Inc., recently introduced their new model gas dehydrator for the dehydration of natural gas streams at flow rates below 1½ Mmscfd. The unit also is designed for cold weather operation.

The dehydrator separates small amounts of condensate and liquid water from the inlet gas, absorbs water vapor from the gas and regenerates glycol for recirculation. It combines these process phases into a pack-

Circle numbers on Readers' Service Cards on last page

aged, skid-mounted unit for convenient field installation.

The unit produces dew point depressions of 55° F. minimum at inlet temperatures of 100° F. when operated in a pressure range of 300 to 1000 psig. Special units are available with dew point depressions of 65° F.

(This item supplements Black, Sivalls & Bryson, Inc., data on Pages 649-660 of the Composite Catalog, 21st Edition.)

For more data, circle **No. E9** on Readers' Service Card, last page this issue.

Neutron Generator

A neutron generator, only three inches in diameter and 47 inches long and incorporated in a standard 3⅝-inch well logging assembly, has been perfected by Well Surveys, an affiliate of Lane-Wells Company, one of the Dresser Industries.

The miniature accelerator was developed and constructed for Well Surveys by High Voltage Engineering Corporation. The complex instrumentation used with the neutron source has been developed by Well Surveys' scientists and engineers.

The accelerator generates electrical potentials up to 200,000 volts which are used to produce a stream of atomic particles called deuterons. These, actually the nuclei of heavy hydrogen atoms, are fired into a target of tritium; the collisions produce an intense yield of neutrons.

These neutrons, travelling at high speeds, penetrate the earth's formations surrounding a borehole and cause various nuclear reactions in the material encountered. These reactions, in turn, yield atomic particles and rays which can be identified and measured by radiation detection equipment which accompanies the accelerator down the hole.

The resulting information, transmitted to the surface and recorded, when correlated with results of neutron radiation research, will help identify and evaluate formation constituents.

For more data, circle **No. E10** on Readers' Service Card, last page this issue.

Fig. 100
1000 p.s.i.
2" to 8"

Dependable, long-lasting, leak-proof service is the principal requisite of unions on production headers. And **WECO** Unions are the perfect answer to these requirements.

Their famous ball and cone seat is precision-machined so that the spherical surface on the male sub seats perfectly on the conical surface of the female sub – thus assuring a positive, leak-proof seal.

That's why – for production headers or any other oil industry services – you'll do better by using **WECO** Unions.

U-10-55

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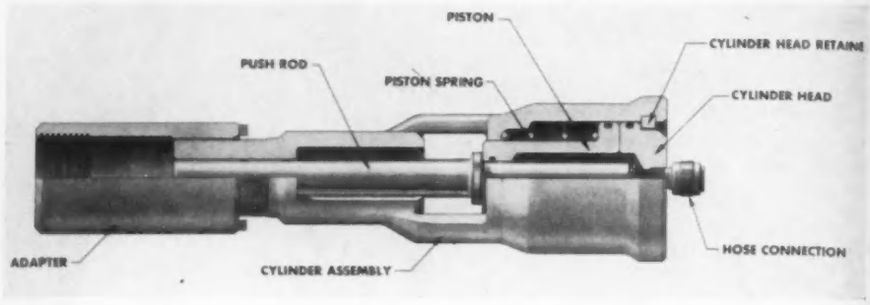
DRILLING



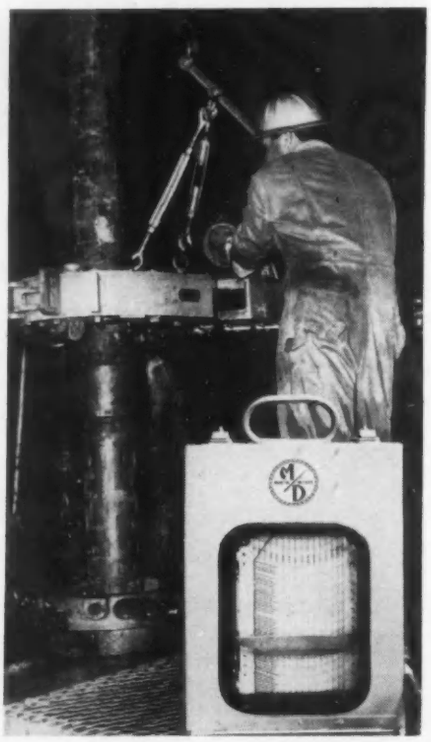
Piston Puller

Pioneer Specialties, Inc. has recently brought out an improved model of their hydraulic piston puller. Like earlier models, it may be used in conjunction with the company's liner puller which removes liners without removing the rod.

The adapter, which screws onto the piston hub first, has lugs on its outer end which fit notches in the rod nut extension wrench to assure that the adapter is screwed all the way on the piston hub. The cylinder assembly is then screwed into the adapter until the push rod is snug against the end of the pump rod, automatically compensating for varying lengths of rod ends and insuring that a few strokes on the hand pump will break the piston free from the rod taper. After the main piston in the puller breaks the pump piston free, the push rod acts as a small auxiliary piston to pull the pump piston out of the liner. Cored openings in the side of the cylinder assembly expose the piston and push rods.

The hose connection is standard and no tools are required to remove the cylinder head for disassembly in servicing the piston or packing.

For more data, circle **No. E11** on Readers' Service Card, last page this issue.



Tong-Torque Gage and Recorder

The Martin-Decker Corporation now manufactures a combination tong-torque gage and recorder. The gage, mounted on the power tong, shows the operator the actual number of foot-pounds of torque being applied, and prevents loose joints or galled threads. The gage has a second pointer that the tong man can set as a target at the established make-up torque.

A remote-reading strip-chart recorder, stationed out of the operator's way, outlines a complete history of the operation. When a copy of the chart is presented to the oil operator at the end of the job, he can tell exactly the number of joints run, the time elapsed, and the amount of torque (in foot-pounds) applied to each joint.

(This item supplements Martin-Decker Corporation data on Pages 3141-3168 of the Composite Catalog, 21st Edition.)

For more data, circle **No. E12** on Readers' Service Card, last page this issue.

Air Drilling Compressor

A line of heavy duty compressors for use in air drilling of oil and gas wells has been announced by The Cooper-Bessemer Corporation. Delivering up to 1500 pounds per square inch air pressure, the new compressor can be operated from existing drilling unit draw works or powered by individual engine prime movers.

Cooper-Bessemer's air drilling compressor is a package unit mounted on skids. It can be moved around easily with drill equipment. A V-belt pulley is used to drive the unit from the conventional draw works power take offs. Such take offs generally furnish up to 1500 horsepower which is used only when pulling the drill string. As a result, there is always ample power available for driving the air compressor during the actual drilling.

For normal drilling requirements, approximately 2000 cubic feet of air per minute are sufficient at 250 pounds per square inch. Clearing clogged bits or blowing water slugged holes call for pressures up to 1000 pounds per square inch.

(This item supplements The Cooper-Bessemer Corporation data on Page 1345 of the Composite Catalog, 21st Edition.)

For more data, circle **No. E13** on Readers' Service Card, last page this issue.

Circle numbers on Readers' Service Cards on last page

Desanding Unit

Dorr-Oliver, Inc., has developed a multiple cyclone unit assembly for the continuous removal of sands and abrasive cuttings from rotary drilling muds. The new Dorrco D-Sander consists of a battery of DorrClone units with feed pump and suitable engine for driving the pump, all unit mounted on portable platform or skids for operation at the drilling rig location, either land or barge.

In operation, mud is pumped from the mud pits through a feed header to tangential inlets into each DorrClone at sufficient pressure to induce a rapid swirling of slurry in the units. The centrifugal force throws the coarse particles and sand to the walls of the lower conical section and down through an orifice at the apex. Bulk of the desanded mud moves to the inner core of the vortex and is discharged upward to the overflow header at the top and returned to the mud storage tanks.

The units are manufactured in two sizes, with capacities respectively of 400 to 500 gpm and 600 to 800 gpm. Feed pump drive may be diesel, gas and/or gasoline, steam turbine or electric motor as required.

For more data, circle **No. E14** on Readers' Service Card, last page this issue.

Core Sniffer

Well Logging Equipment Manufacturing Company (associated with Warren Automatic Tool Company) is now manufacturing the Wemco Core Sniffer which is designed to detect gas accurately and quickly.

The Wemco Core Sniffer is built to be used in the field. It has the sensitivity of a laboratory instrument with the ruggedness, light weight and ease of operation needed at the well. It is simple to operate.

Instant interpretation of the indicator on the Wemco Core Sniffer discloses the absence or presence of minute units of gas in each core tested. The simplified design reduces weight without sacrificing accuracy of measurement. Using only the instrument itself for self-checking, the operator can check its correct operation in a matter of seconds.

The sniffer uses a standard radio "A" battery which can be operated continuously for 18 to 20 hours before replacement is necessary.

For more data, circle **No. E15** on Readers' Service Card, last page this issue.

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SERVICING OIL & GAS WELLS

T-O THICKENED OIL

T-O *(Thickened Oil)* is The Chemical Process Company's new low-cost fracturing fluid. Made on-location from crude oil, kerosene, or Diesel oil, T-O is ready for use within 30 minutes after mixing has begun. T-O has:

HIGH VISCOSITY▼▼▼▼
for good sand carrying ability

LOW FLUID LOSS▼▼▼
for deeper and better fractures

INTERNAL BREAKER▼▼
for faster, more complete clean-up

LOW FRICTION LOSS▼
for lower injection pressure

GOOD COMPATIBILITY
with demulsifying agents or additives such as Adomite to lower fluid loss.

Fracturing treatments with T-O are giving excellent results. A gas well in Hansford County, Texas, increased from a potential of 9,000 to 68,000 MCF after treatment with 20,000 gallons of T-O (made from kerosene). T-O approaches the ideal fracturing fluid. Your nearest Chemical Process Company office will be glad to give you additional information, or write to us at P. O. Box 831 in Breckenridge, Texas. There is no obligation.

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New Equipment Catalogs and Literature

For more data on New Equipment or copies of Catalogs and Literature reviewed in this issue, use the Readers' Service postcards just inside the back cover and facing the Advertisers Index. Simply circle code numbers of items desired—sign and mail card. Requests are transmitted to the manufacturer as soon as received by us for mailing of desired information directly to you.

Swivel Bulletins

The National Supply Company announces release of new bulletins covering their series of Type "N" swivels. With the series comprising a complete line of advance-design swivels for drilling operations from 3000 to 15,000 feet, complete information on all new features is included in the literature. Among the features described are: Uniflex wash pipe packing assembly which provides an improved method for packing off the mud, reduces mud swirling and fluid cutting at ends of wash pipe and has quick-breaking threads to permit fast replacement; precision-machined main bearing with rollers and race plates lapped in matched sets for proper load distribution; smooth-contoured gooseneck to minimize mud resistance and erosion; streamlined swivel body cast in one piece from Ideal electric steel; and automatically induced oil circulation through large passages between the upper and lower portions of the bearing enclosure when the swivel is rotating.

To get a copy, circle **No. E16** on Readers' Service Card, last page this issue.

Gravity Conservation

Black, Sivalls & Bryson, Inc., announces publication of an illustrated bulletin on gravity conservation that summarizes several important gravity conservation methods now being practiced in the oil fields and introduces some new thinking that recently has been developed.

Divided into four main sections, the bulletin discusses the importance of conservation in terms of dollar return, reviews equipment now being used on the storage tank to increase vapor conservations, explains how other types of equipment on the lease play an important part in gravity conservation and discusses new aids in gravity conservation, especially in the field of gas processing equipment such as low temperature separation.

To get a copy, circle **No. E17** on Readers' Service Card, last page this issue.

Plastics Literature

Tube-Kote, Inc. recently published new literature on its TK-2 plastic lining, new custom coating process and a new product, TK-31, a modified Epoxy plastic coating.

The TK-2 plastic lining literature points up applications for the lining as a specific preventative of corrosion damage and paraffin deposition. Actual case histories are used to show results of lining equipment with TK-2.

Literature covering the Tube-Kote plastic service, custom coating, explains how specialty items can be protected against corrosion, contamination and sticking.

TK-31, modified Epoxy coating, is introduced in a circular which lists its applications. The literature explains what can be expected of the product and why it is a practical coating for tubular goods and many other oil field and refinery uses.

To get a copy, circle **No. E18** on Readers' Service Card, last page this issue.

Hydraulic Tables Handbook

Aldrich Pump Company recently announced publication of a new edition of their Bulletin Number 50, "Handbook of Hydraulic Tables and other engineering data." This is one of several editions of the comprehensive reference work for hydraulic engineers interested in pumping and piping problems.

To get a copy, circle **No. E19** on Readers' Service Card, last page this issue.

Oil Well Pump Bulletin

The Axelson Manufacturing Company's "2-stage" pump is outlined in a new bulletin released by Axelson, division of U. S. Industries. The new, improved, down-hole pump prevents gas lock in the pump or pumping off in a low-level well. Lift is obtained from two producing chambers (the primary and secondary state) in which gas is compressed to aid in continuous flow.

To get a copy, circle **No. E20** on Readers' Service Card, last page this issue.

Turbodiesels

The answers to many questions on turbocharging can be found in Cummins Engine Company's latest booklet. Also included are illustrations and complete descriptions of the company's five turbodiesels, the 175-horsepower JT-6; the 250-hp NT-6; the 262-hp NTO-6; the 300-hp NRT-6; and the 600-hp VT-12.

To get a copy, circle **No. E21** on Readers' Service Card, last page this issue.

Weight Indicator Data

In a new Martin-Decker brochure, "How Your Weight Indicator Works—A Nontechnical Discussion of Weight Indicators for the Man on the Rig Floor," the pros and cons of different kinds of weight indicators and the applications for which they are best suited are presented. A discussion of hydraulic principles and factors that affect weight indicator readings also is included.

To get a copy, circle **No. E22** on Readers' Service Card, last page this issue.

Mud Supply, Services Catalog

Baroid Division, National Lead Company, has released the 1955-56 catalog of their products and services. Accompanying the description of each product is a resume of the varied uses where it can be used to advantage. Performance curves, material requirements tables and associated data also are included.

To get a copy, circle **No. E23** on Readers' Service Card, last page this issue.

Plunger Lift Systems

The National Supply Company has completed a general information phamplet on Ideal plunger lift systems and automatic control equipment. The booklet explains how production and well lifting costs can be improved with installation of these modern plunger lifts. Ease of installation, adaptability and application to open or closed system wells are described.

To get a copy, circle **No. E24** on Readers' Service Card, last page this issue.

Mobile Radio Units

Motorola's catalog on its recently announced TWIN-V line of mobile two-way radio units provides a guide to the various factors to be considered in selecting equipment—available frequencies, types of power supplies, types of mounting and transmitter power outputs. Included is a detailed listing of ten features which help assure the radio user of optimum performance. Among these are interchangeability in mixed fleets of 6 and 12 volt cars, transmitter deviation limiting, ease of maintenance and availability of nation-wide service facilities.

To get a copy, circle **No. E25** on Readers' Service Card, last page this issue.

Drilling Tool Catalog

A comprehensive, illustrated catalog has been released by Bowen Company of Texas, Inc., which covers major models of overshots, spears, cutters, casing patches, scrapers, a patented hydraulic rotary jar, fishing and drilling bumper subs, safety joints, line wipers, wire line equipment and other additions to the company's regular line of drilling tools. Sections of the catalog cover construction, assembly, operation and maintenance of each tool and carry complete illustrations working parts and prices.

New types of equipment are described in detail for the first time, including a wire line weight indicator and wire line blowout preventer.

To get a copy, circle **No. E26** on Readers' Service Card, last page this issue.

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• Dot preceding name of advertiser indicates that detailed data on products and services of the firm will be found in current 20th (1953-54) edition of The Composite Catalog of Oil Field and Pipe Line Equipment.

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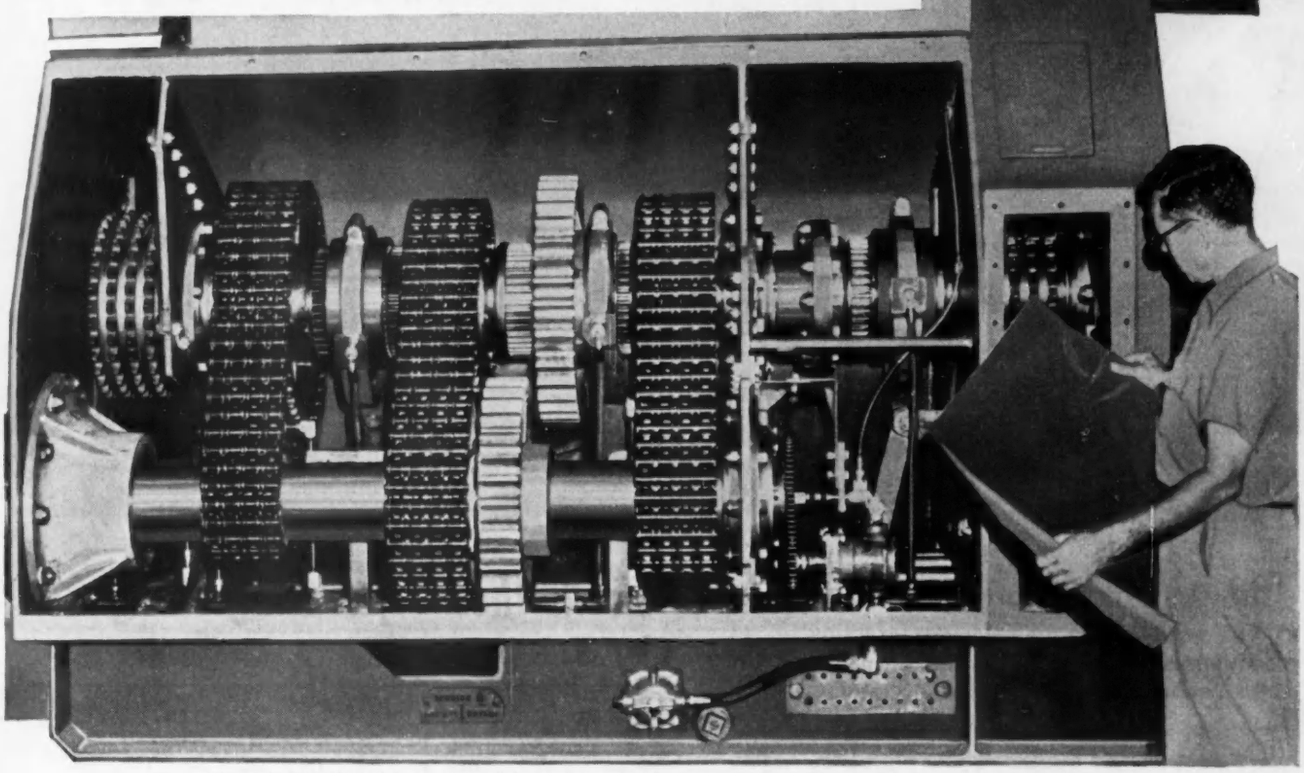

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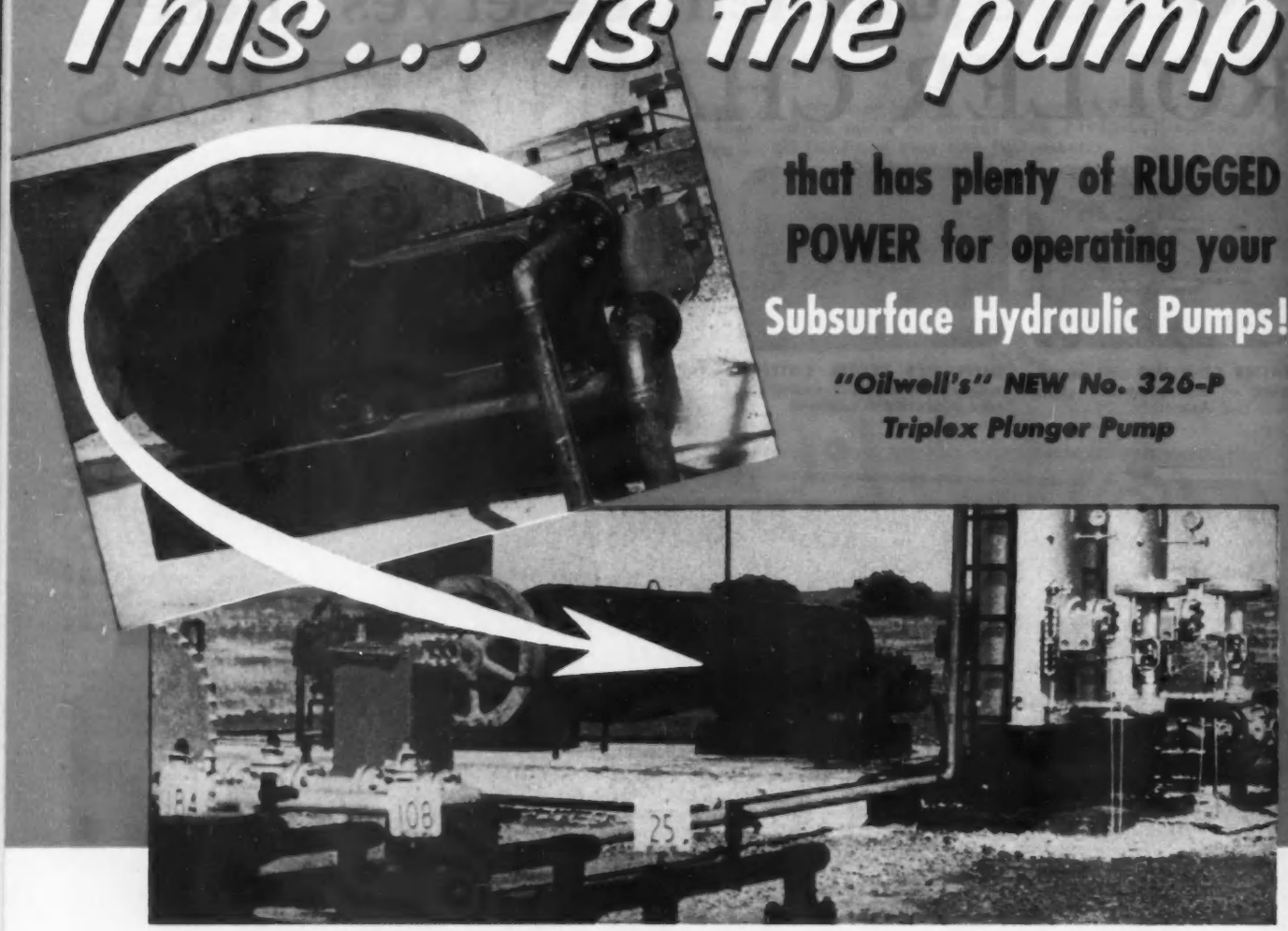

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1¾	4150	.188	389	518	648	778	907	1037	1167	1297
2	3180	.245	501	667	835	1002	1168	1335	1502	1670
2¼	2520	.310	639	852	1064	1277	1490	1703	1915	2125
Pinion Shaft rpm with: Gear Ratio, 4.44:1			266	355	444	533	622	710	800	888
Gear Ratio, 3.12:1 *			187	250	312	375	437	500	562	624
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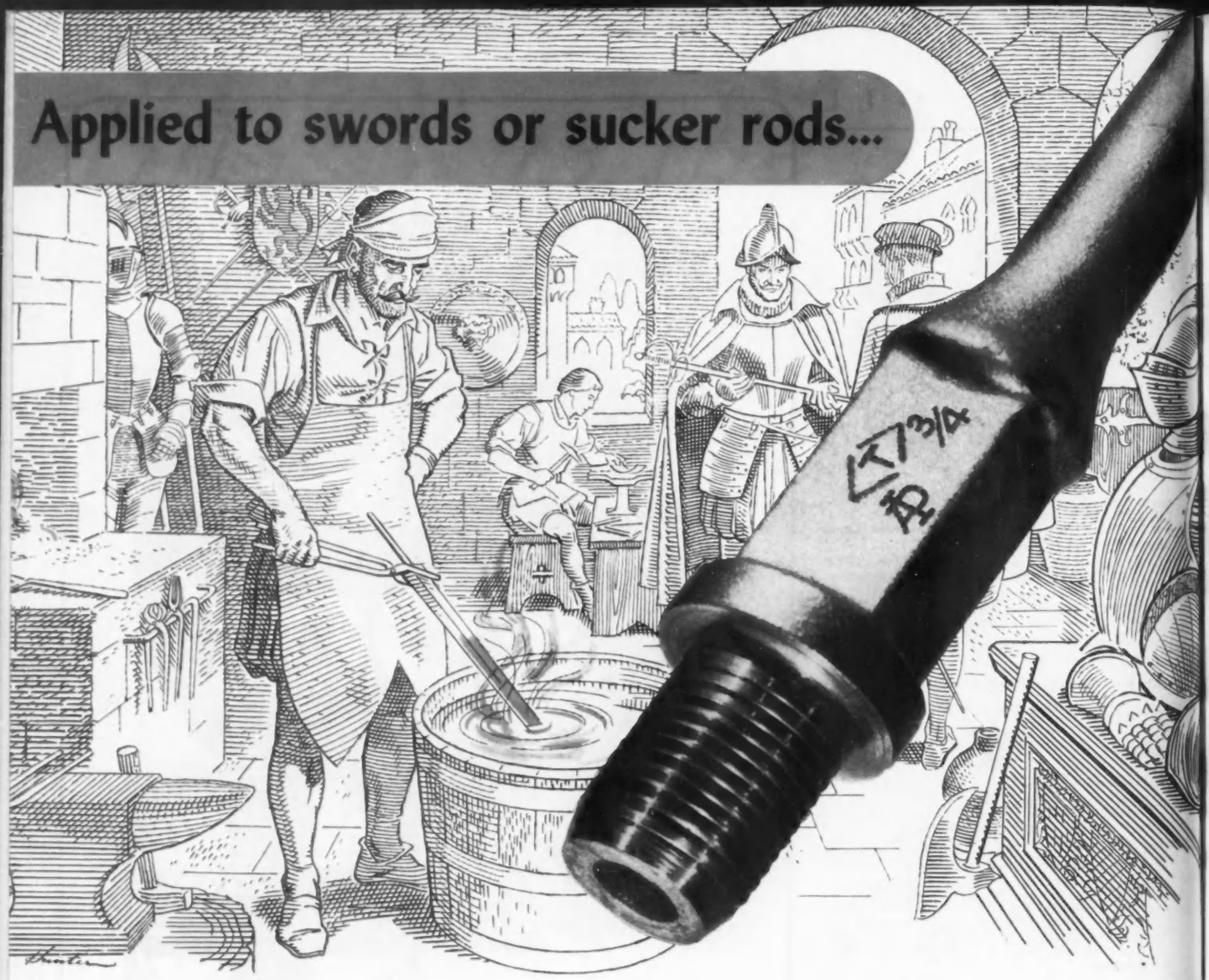

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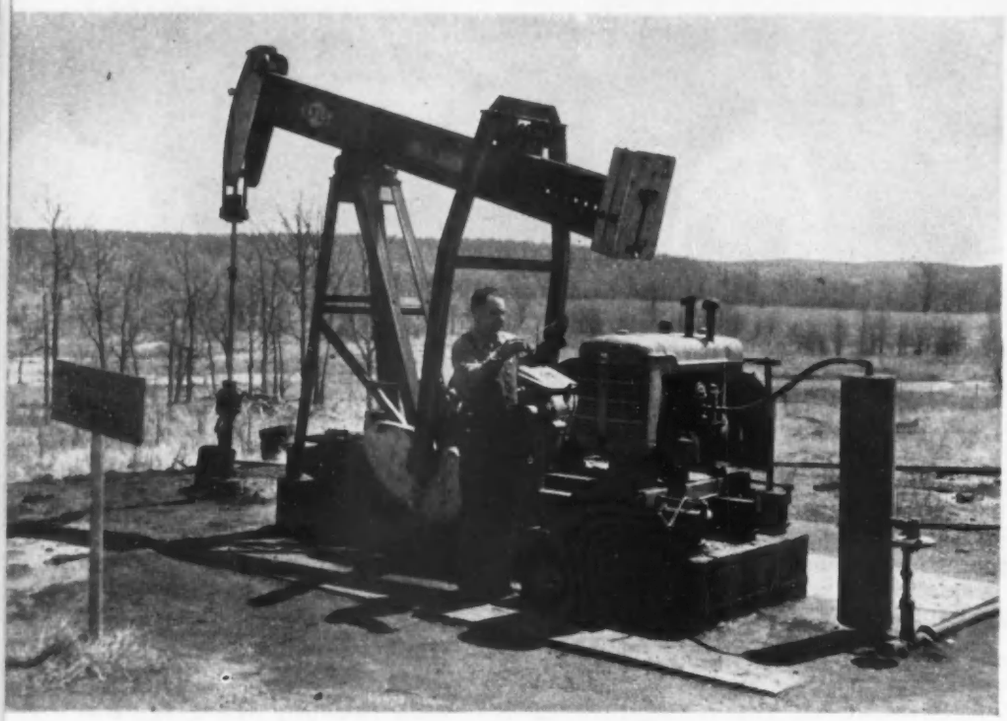
6 years, no overhauls—TD-14 with Superior Pipe-Boom, rear right, was bought by Luther Harper, Turley, Oklahoma pipe-layer, in 1949. In 10,000 hours since then, it has needed no major overhauls. TD-14, with Superior Boom, foreground, newest of Harper's 6 International crawlers, was bought for this job—laying 3½ miles of 12 inch gas line in East Tulsa. Last year, Mr. Harper's 6-unit IH fleet put in or removed 160 miles of pipe, some 24 inches in diameter.



120 IH engines for L. B. Johnson, used by this Kiefer (Okla.) company on wells near Tulsa. Here, Master Mechanic Joe Vanardel inspects a 24 hp U-2A which pumps a 1700-ft. well. "International engines are easy to work on and low in maintenance cost," he says. "Some of our units haven't needed any work in 4 years. Others, on continuous hard-pumping wells, easily run a year, 24 hours a day, between overhauls."

Contract-drilling in Louisiana, Lloyd & Langston report the 83 hp butane-burning International engine which powers their drill rig "has needed no repairs in 2 years of use." Rig is shown drilling 3500-ft. well at Hosston.

Digs oil reserve pit—That's just one of many tasks Dick Sieber Excavating Co., Pauls Valley, Oklahoma, assigns their 4 TD-14's. "New TD-14's provide solid comfort," says Operator Lloyd Nelson. "I can really relax in the big, soft seat. Operation is simpler, too. Controls are handy—right where I can reach them naturally. And I'm sure going to appreciate the open deck on those hot days next summer!"

elds 55 mi. gas line—two 40-volt weld-s on TD-14 provide power for stringing e, Seneca, West Virginia, to Woodstock, rginia. Pipeline Construction & Drilling mpany, Camp Hill, Pennsylvania, weld 500 feet daily with this rig.

Clears 50-ft. right-of-way—Clearing on same job described left is being done by TD-24 shown, plus 2 TD-18's and 2 TD-9's. Despite rough, rocky, mountainous terrain and 4500-ft. altitude, fleet clears an average of ½ mile per day.

"Best for backfilling" says R. M. Paylor, Pipeline Construction & Drilling Co. foreman, of International Drott TD-9. "It has highest reach and best balance of any equal-size loader. Hydro-spring sure saves wear in rough rock work."

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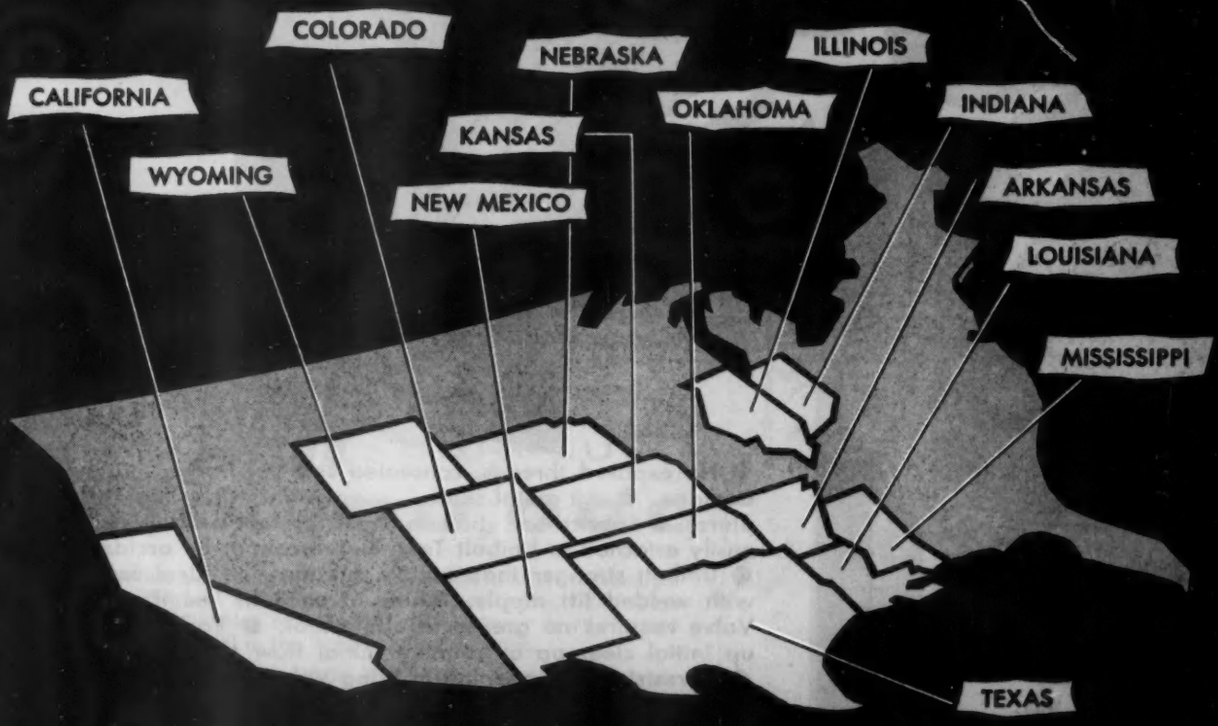

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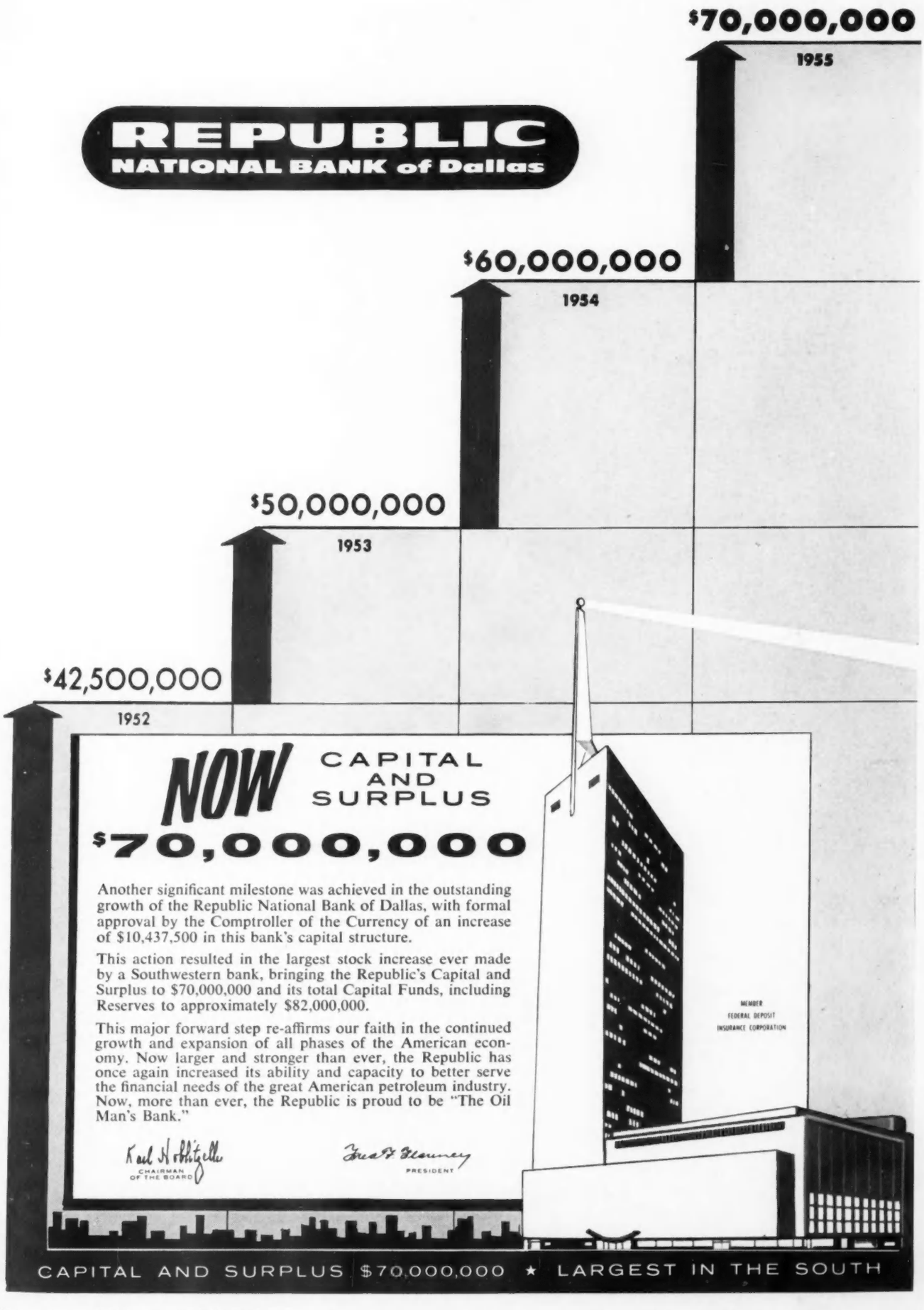
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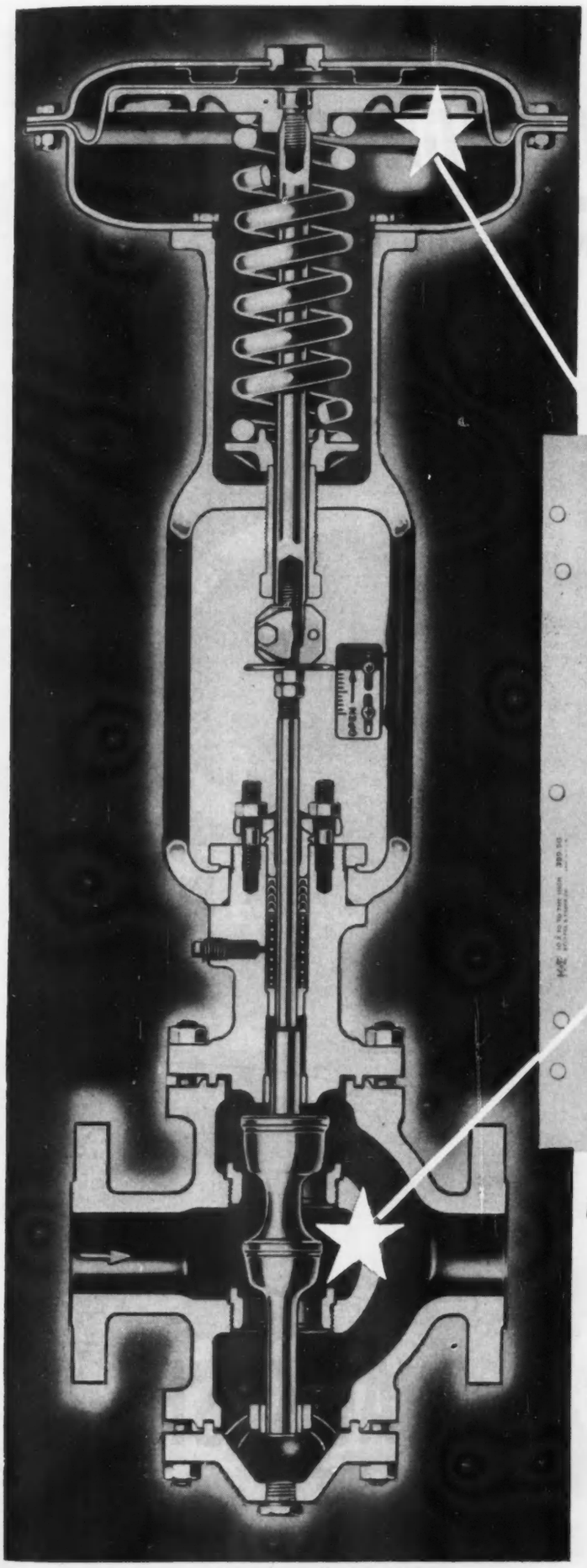

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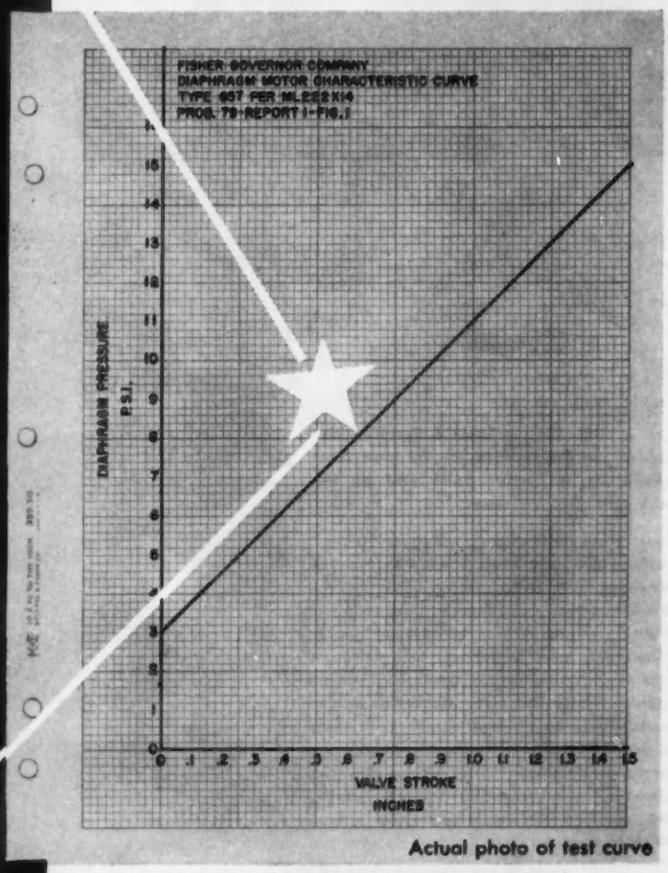

Actual photo of test curve

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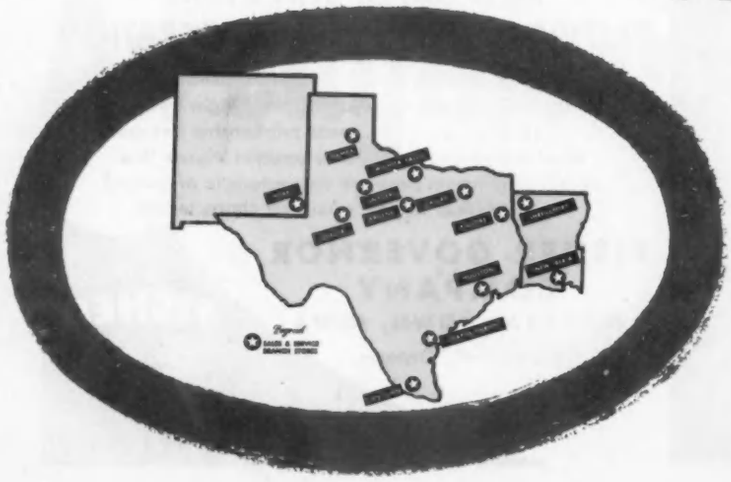

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Quantitative analysis for origin of gases in drilling muds by spectroscopy.

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Petroleum Service

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ALAMO NATIONAL BUILDING

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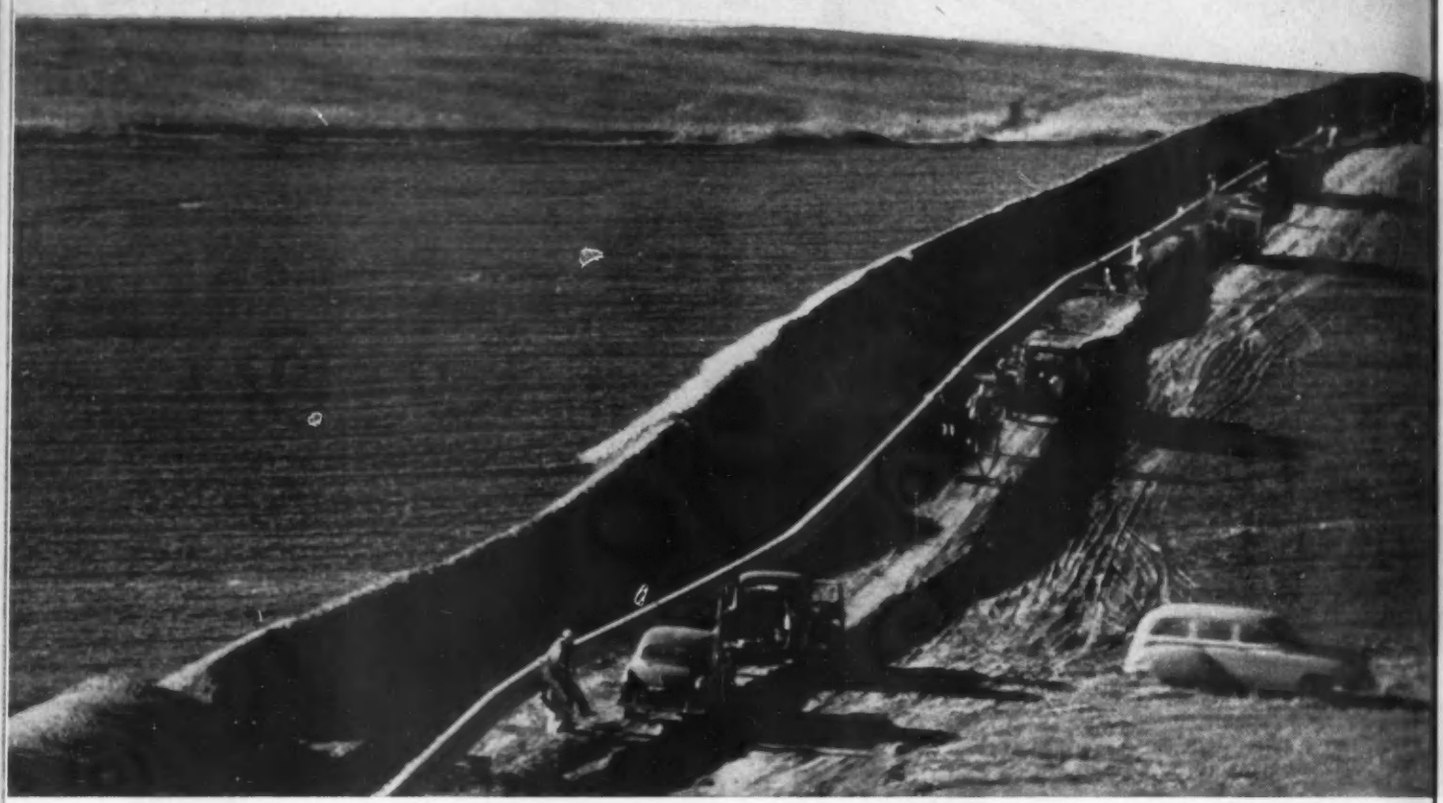
SERVICE PIPE LINE'S



Pipe welders at work on the rolling fields of Kansas.

A watertight pulling dome or "head" welded onto the line in preparation for one of the eight major river crossings.

A section of 24" O.D. x .500" wall National Seamless Pipe, coated for the Solomon River crossing. The covering consisted of a dope primer impregnated with fibre glass paper and coated with two inches of cement.

NATIONAL SEAMLESS PIPE AND TUBES

625-MILE "BIG INCH"

from Wyoming to Missouri contains 45,000 tons of NATIONAL SEAMLESS

USS National Seamless Pipe—45,000 tons of it—in sizes 20″, 22″, and 24″ O. D. are now helping to carry millions of barrels of crude oil from the Rocky Mountain producing areas to midwest refining centers.

Starting at Fort Laramie, Wyoming, the new line runs through the Denver-Julesburg Basin of Colorado and Nebraska and is linked to west Kansas producing fields. It ties into Service Pipe Line Company's main North-South system at the western edge of Missouri.

The present outlet capacity is 160,000 barrels per day. It can be economically expanded to 245,000 barrels per day. Initially, more than 1,500,000 barrels of oil were required to fill the line.

The installation of this line brought about a new pipe-laying record—an average of over 10 miles a day. Eight spreads welded as high as 108.6 miles of pipe in one week, and up to 17.4 miles in a single day! This is a tremendous accomplishment in view of the fact that the line passes under 49 highways, countless roads, 21 railroads, eight major rivers, and spans innumerable irrigation ditches.

This type of rugged service calls for exceptionally strong, uniform, flexible pipe that will endure crushing underground and underwater stresses. And most important – it must be pipe that can be depended upon to give long, trouble-free service. This is USS National Seamless Pipe, "Walls Without Welds" . . . and these are the reasons why it is chosen so consistently to do the job.

A cinch bending machine in operation on a section of National Seamless in the Boyd, Kansas, area.

"WALLS WITHOUT WELDS," the vivid story of the manufacture of National Seamless Pipe and Tubes is available free of charge for showings to industrial groups, clubs, school groups, etc. This educational sound film in brilliant technicolor contains some of the most dramatic steel mill operations ever recorded. Write to Motion Picture and Visual Aids Section, United States Steel Corporation, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

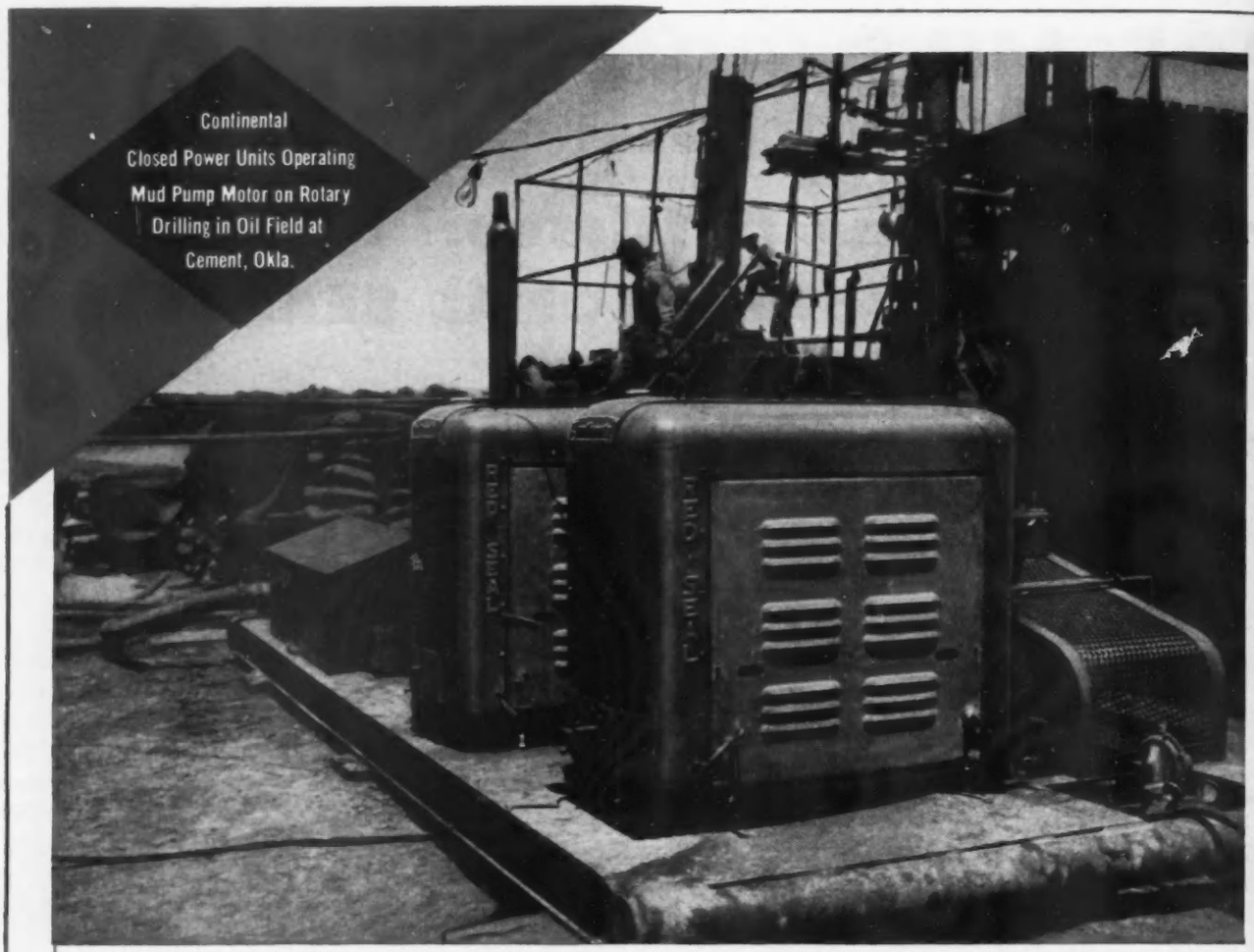
In Pipe Lines Too . . . Seamless Does It Better

SEE The United States Steel Hour. It's a full-hour TV program presented every other week by United States Steel. Consult your local newspaper for time and station.

NATIONAL TUBE DIVISION
UNITED STATES STEEL CORPORATION, PITTSBURGH, PA.
COLUMBIA-GENEVA STEEL DIVISION,
SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY NEW YORK

USS

UNITED STATES STEEL



CONTINENTAL RED SEALS
Run for Years and Years

Throughout the oil fields—in all types of installations—you'll find proof of the stamina that has made Continentals first choice for so many tough jobs. Many of them older than the units shown above are still turning in their full work quota, week in and week out, year in and year out—and, many of them under the least favorable operating conditions. Today's line of Continental Red Seal engines is up-to-the-minute mechanically, as well as broader and more diversified than ever before. There are Red Seal models engineered to the specialized needs of practically every oil field application—models at closely-spaced levels—14 to 240 horsepower—for use on all standard fuels. And, you may be sure of one thing: no other engine built today will give longer service, with less time out, than the Red Seal model engineered and built for your job.

Continental Motors Corporation

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for better economical casing perforating . . . Twin Jets fill the bill.
for better squeeze cementing . . . Four shots in a plane from 4-Way Jets.
Welex Perforating SPECIALISTS . . .
for every completion need
A jet perforator for every job . . . and every one developed by Welex to meet a specific need. All jets have been thoroughly tested and proved. When you call on Welex . . . you will get exactly the right type and size of jet that will give you maximum performance and better completions.
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CALL WELEX AND BE SURE!!
for better open hole shooting . . . Maximum power Torpedo Jets.
for better permanent-type completions . . . Swing Jets for full power thru tubing.
for better jet casing perforating . . . A Perfo-Jet gun for every size of casing.

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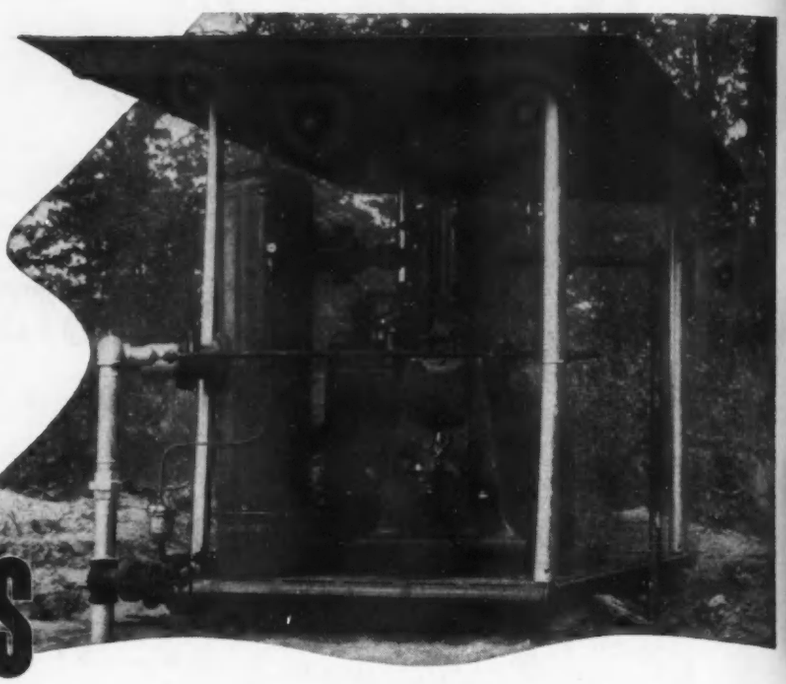
JOY PACKAGED GAS COMPRESSORS



JOY CLASS WGB-110 GAS COMPRESSOR:
Inlet pressure—50 Psig., Discharge Pressure—200 Psig., Capacity—.5 MMCFD.

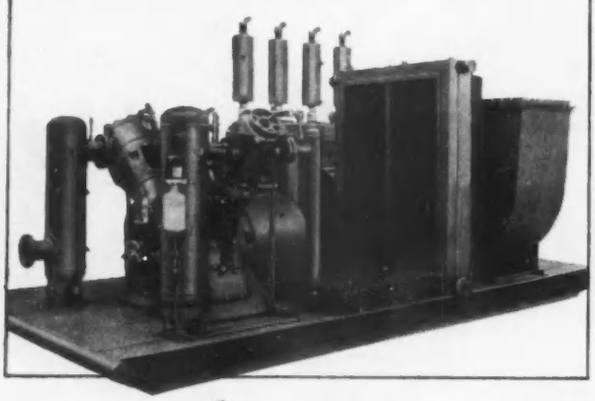
the only modern-design compressors for gas booster operation

No other gas compressors available today for booster service were designed as recently as the Joy Packaged Units, and offer as many modern advancements in design for field-proved economy and efficiency.

Best of all, these modern Joy Compressors are backed by a century-old reputation for low maintenance and long, uninterrupted operation. They are the most reliable you can put on the job for gas gathering, repressuring, or gas lifting . . . *because of these time-proved features:*

1 Field-replaceable cylinder liners.
2 Field-replaceable crosshead guides.
3 Patented Joy "Dual-Cushion" valves.
4 Full force-feed lubrication.
5 Anti-friction main bearings.

JOY CLASS WNB-112 GAS COMPRESSOR:
Inlet pressure—20 Psig., Discharge Pressure—650 Psig., Capacity—.8 MMCFD.



Available in vertical, V-type, and semi-radial designs for minimum space requirements, Joy gas compressors may be single- or two-stage units with cylinder sizes ranging from 3″ to 13½″. Four different frame types are available for a range from 50 to 400 H.P.

Your Joy representative can specify the most efficient compressor for your needs. Call him or write for Bulletin A-94. ***Joy Manufacturing Company, Oliver Building, Pittsburgh 22, Pa.*** In Canada: *Joy Manufacturing Company (Canada) Limited, Galt, Ontario.*

Consult a Joy Engineer

W&D I 5466

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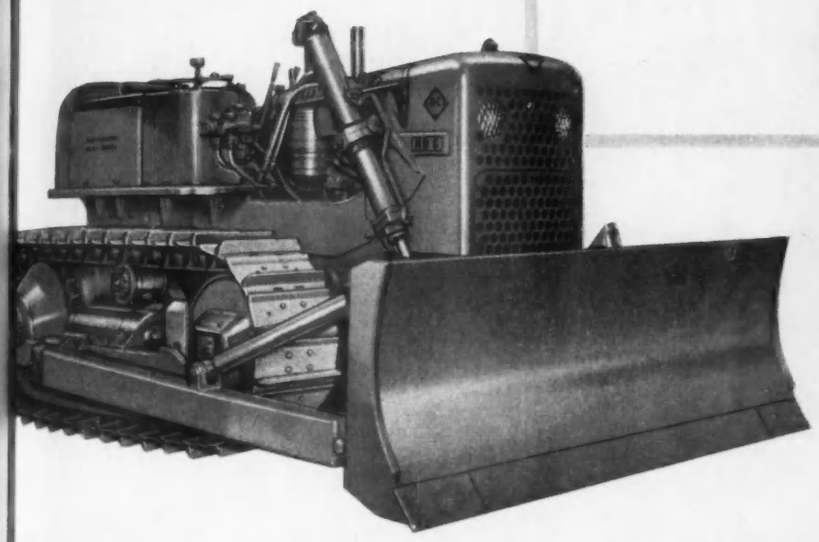
FOR SUSTAINED HIGH OUTPUT!

more versatility
FOR A WIDER RANGE OF WORK!

more dependability
FOR LOWER JOB COSTS!

ALLIS-CHALMERS ANNOUNCES TWO NEW HD-6 SERIES TRACTORS



HD-6 BULLDOZER-DRAWBAR TRACTOR

Weight	12,400 lb
Drawbar hp	45
Belt hp	55

STEP UP PERFORMANCE, CUT JOB COSTS WITH EXCLUSIVE HD-6 FEATURES LIKE THESE . . .

- Allis-Chalmers heavy-duty diesel engine
- Long-wearing ceramic master clutch lining
- All-steel box-A main frame
- One-piece steering clutch and final drive housing
- Double reduction final drives
- Roller bearing truck wheels
- Welded steel truck frames
- Tru-Dimension tracks
- 24-volt direct electric starting
- Unit construction
- 1,000-hour lubrication intervals
- Engine-mounted bulldozers

. . . PLUS TRACTOR SHOVEL FEATURES LIKE THESE . . .

- Extra-long track with six truck wheels per side
- New two-position bucket
- Heavy-duty shovel assembly
- Simple, safe hydraulic system
- Two-speed reverse

HD-6G TRACTOR SHOVEL

Weight	19,600 lb
Drawbar hp	45
Net engine hp	57
Bucket capacity	1-1/3 cu yd

GET ALL THE FACTS NOW FROM YOUR NEARBY ALLIS-CHALMERS DEALER

CONSTRUCTION MACHINERY DIVISION, MILWAUKEE 1, WISCONSIN

ALLIS-CHALMERS

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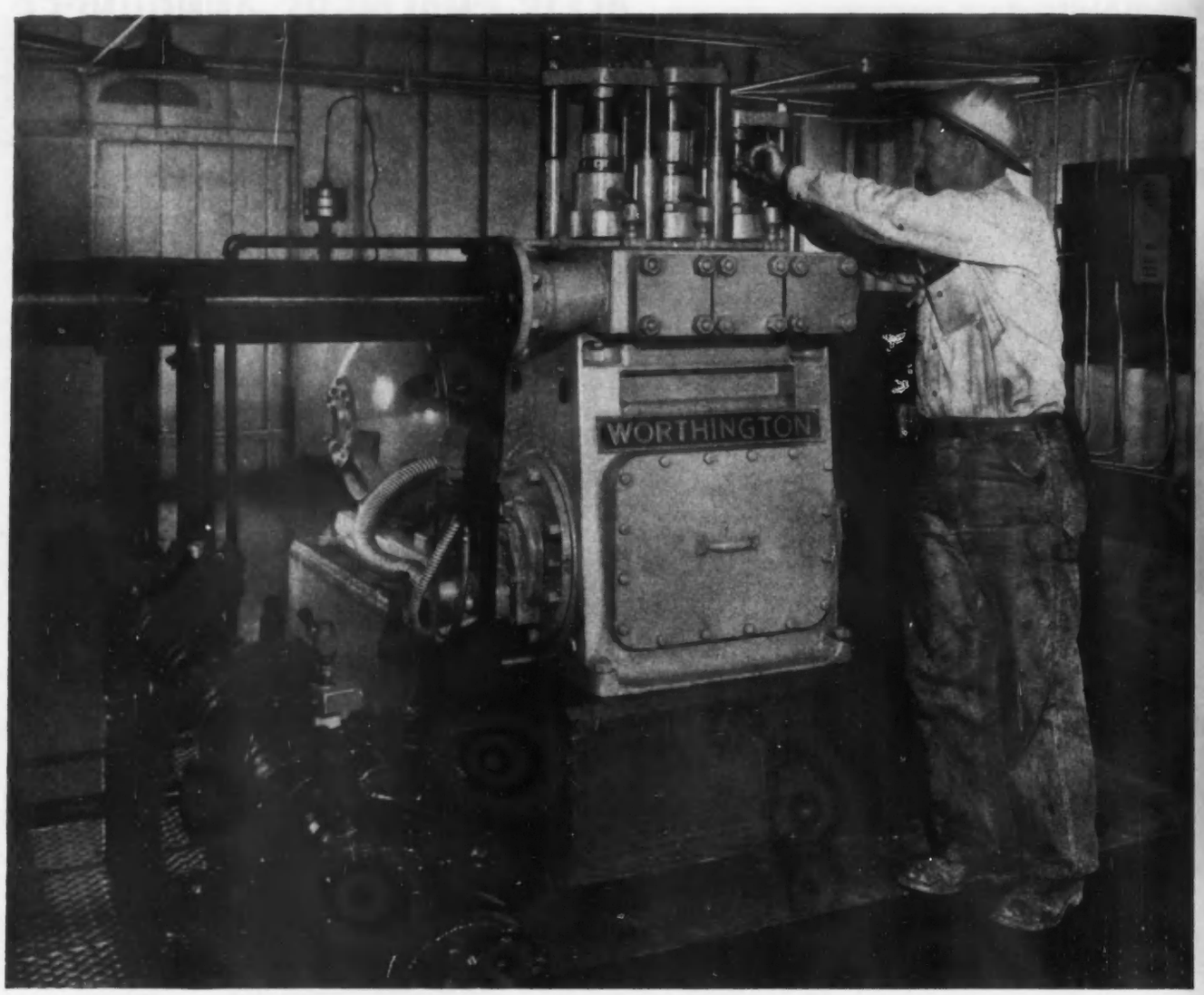


WORTHINGTON WATERFLOODING PUMP on the job at a large Oklahoma oil field installation. Power for the pump is transmitted by Worthington QD Sheaves and Worthington-Goodyear V-belts.

Worthington and waterflooding...the right combination

It's like a word association test. Mention "waterflooding" and somebody pipes up with "Worthington".

There's good reason for that close identification. Since the early days in Pennsylvania, Worthington waterflooding pumps have been the overwhelming choice of oil men. Why? Because Worthington vertical power pumps give you all the features demanded in a waterflooding pump.

Take a look at some of the features built into today's Worthington vertical power pumps.

- **INDIVIDUAL VALVE COVERS** — make inspecting and servicing valves quick, easy.
- **SEPARATE STUFFING BOX DRAINS** — leakage can never corrode plunger barrel or cylinder.
- **SOLID CERAMIC PLUNGER** — the strongest, most corrosion-resistant possible.
- **DOUBLE-PORTED VALVES** — for greater flow through a given seat diameter.

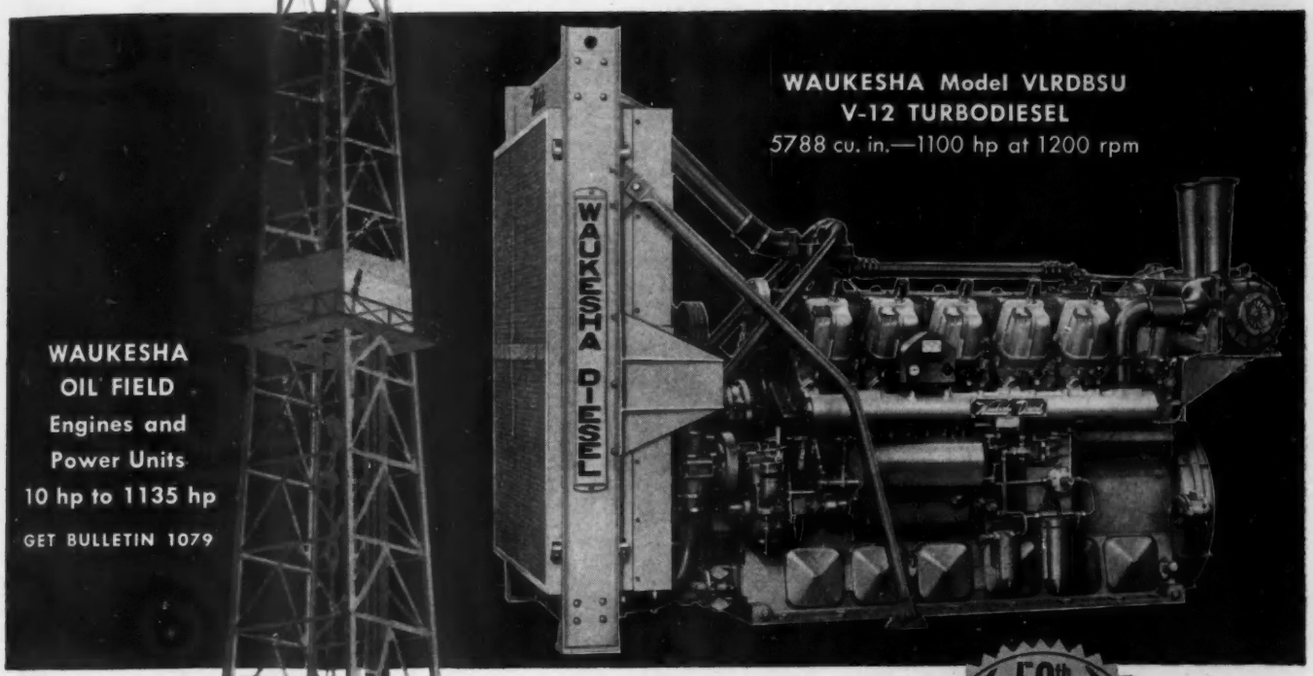
It all adds up to this: for *any* waterflooding job (from the smallest pilot flood to the largest community project), a Worthington pump is the *right* answer. See your local Worthington man today — or write for new bulletin W-414-B21 on Worthington waterflooding equipment to Worthington Corporation, Harrison, N.J.

P.4.2

WORTHINGTON

Air Compressors • **Pumps** • **Multi-V-Drives** • **Allspeed Drives**

FOR off-shore DRILLING



WAUKESHA Model VLRDBSU
V-12 TURBODIESEL
5788 cu. in.—1100 hp at 1200 rpm

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OIL FIELD
Engines and
Power Units
10 hp to 1135 hp
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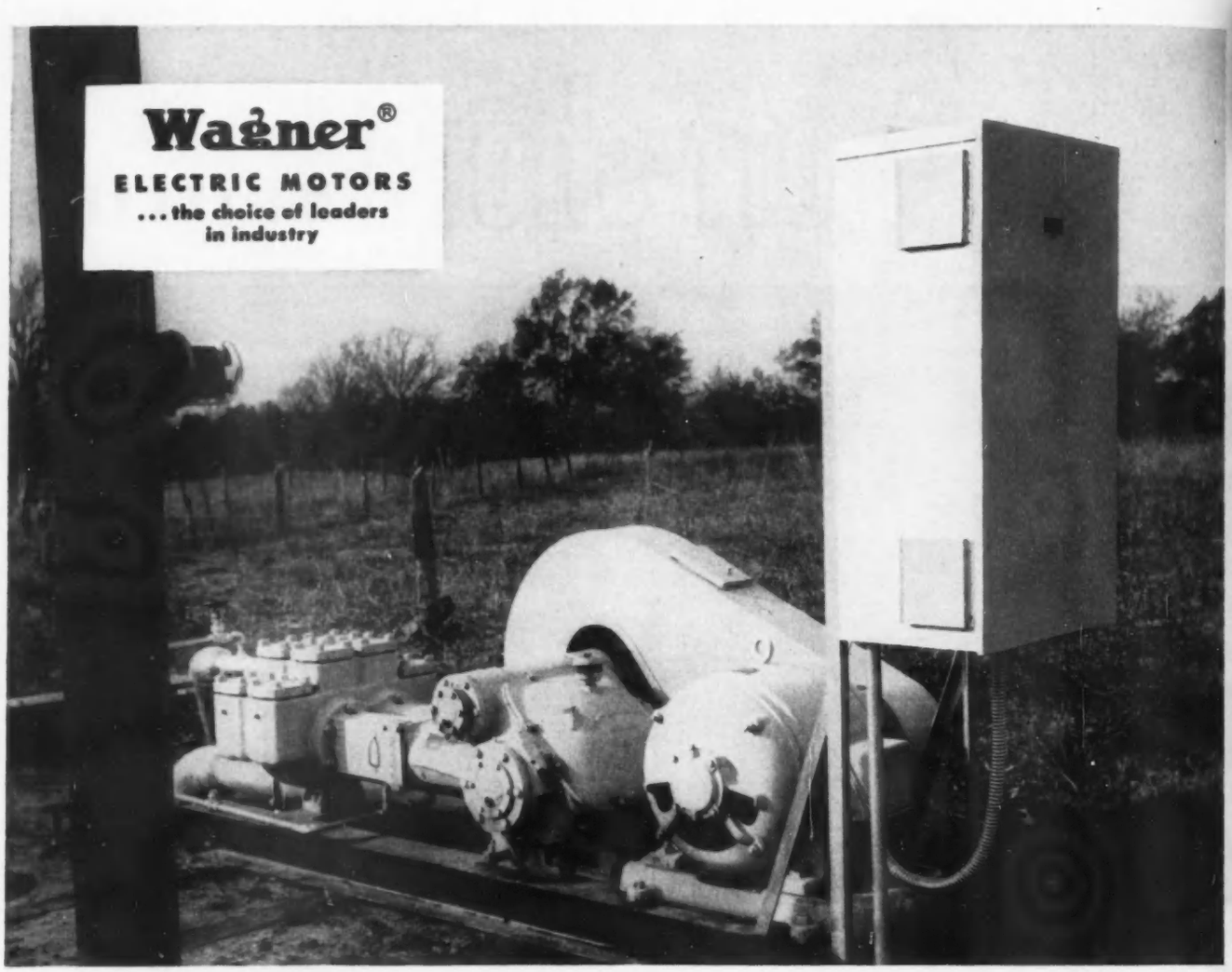
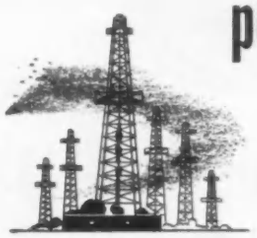


portable power for the petroleum industry



American Oil Pipe Line Company pipes crude oil from lease tanks to storage tanks of oil refineries. The network of pipe in a field is called a "gathering system."

At various gathering system locations, you'll find gathering pumps which keep the heavy crude oil coursing through the pipeline. These gathering pumps are put on skids so they can be moved about to give the system greater flexibility. American can move its pumps quickly and easily whenever new pipe is added or old pipe is abandoned.

A 25 horsepower Wagner motor is the hard-working heart of each of these portable pumps. Wagner motors are chosen for this application because they go about their ceaseless job of hurrying crude oil to the refinery with complete dependability and a minimum of maintenance.

Perhaps you have a specialized motor application ... if so, remember, there's a Wagner motor to fit every need ... a complete line for all current specifications with a wide variety of enclosure types and mountings.

Your nearby Wagner engineer can help you select the *right* motor to meet your specifications. Call the nearest of our 32 branch offices or write us.

Wagner Electric Corporation
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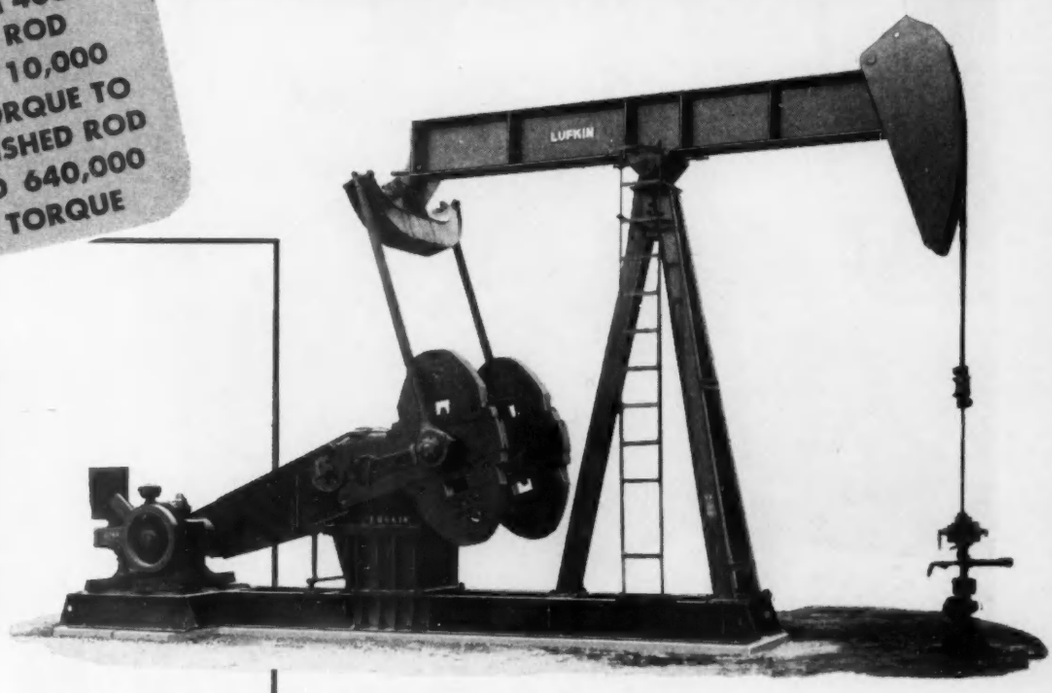
WM55-8

ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES • AUTOMOTIVE BRAKE SYSTEMS-AIR AND HYDRAULIC

LUFKIN continues to maintain its leadership in the pumping unit field with the NEW C LINE

OF IMPROVED CRANK BALANCED UNITS

OVER 40 SIZES RANGING FROM 4000 LB. POLISHED ROD CAPACITY AND 10,000 IN. LB. PEAK TORQUE TO 30,000 LB. POLISHED ROD CAPACITY AND 640,000 IN. LB. PEAK TORQUE



STANDARD ASSEMBLIES

C-640DB-144-30
C-640DB-120-30
C-640DB-108-30
C-456DB-144-30
C-456DB-120-30
C-456DB-108-30
* C-320D-120-25
C-320D-84-30
C-320D-84-27
C-320D-74-27
C-320D-74-25
C-228D-74-27
C-228D-74-23
C-228D-74-20
C-228D-64-23
C-228D-64-20
C-160D-74-20
C-160D-64-23
C-160D-64-15
C-160D-54-18
C-160D-54-17
C-114DA-64-15
C-114DA-54-17
C-114DA-54-16A
C-114DA-54-15
C-114DA-54-14
C-114DA-54-13.5
C-114DA-48-14
C-114DA-42-10.5
C-80DB-48-14
C-80DB-42-10.5
C-57D-48-10
C-57D-42-10.5
C-40D-40-7.4
C-40D-34-8
C-25D-28-6
C-25D-24-6

These Units Are Also Available With Single Reduction Gear Reducers

The new "C" series offers a greater variety of combinations of torque, counter-balance, and polished rod capacity to suit any conceivable well condition.

LET YOUR LUFKIN REPRESENTATIVE ASSIST IN SELECTING THE PROPER AND MOST ECONOMICAL UNIT FOR YOUR REQUIREMENTS.

EXPLANATION OF UNIT DESIGNATION

* **C** —For Crank Counterbalance
320D—Gear Reducer (320,000 Lb. In. Peak Torque Double Reduction)
120 —Maximum Stroke (120 Inches)
25 —Peak Polished Rod Capacity (25,000 Lb.)

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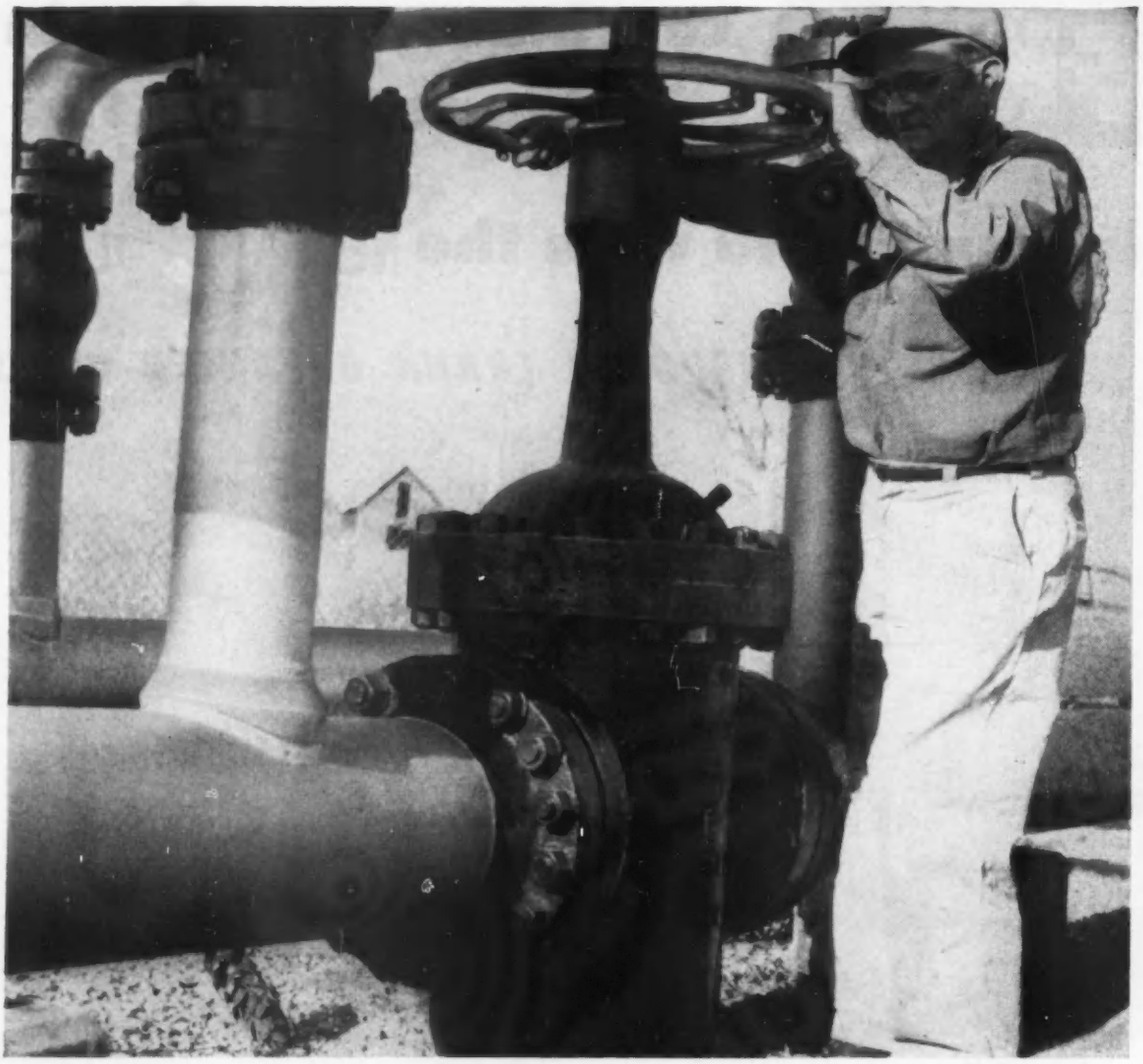

Easy does it...year after year with this Crane pipe-line valve

THE CASE HISTORY—More than 3 years ago the Phillips Pipe Line Co. installed this Crane conduit valve in a junction manifold on its 10-inch crude line to Borger, from Yale Station, Oklahoma. How's it doing?

Operated every day or two until a few months ago, this Crane double-seating, grease-packed valve has always responded smoothly and easily to the handwheel—never sticking. Under former frequent usage as now with infrequent operation, it has never leaked at the bonnet joint or packing chamber—remains tight as new at the seats. This Crane valve—because its pressurized stuffing box eliminates leakage—is clean, unstained.

On gas and oil, these Crane valves are making big savings in operating costs. They're the leading value for pipe line service, and thrifty buyers know it. Crane Co., General Offices, Chicago 5, Illinois. Branches and Wholesalers in all industrial areas.

CLASS 600 STEEL PIPE-LINE GATE VALVES

Grease packing in body and bonnet assures thorough internal lubrication for easy operation. Parallel disc design gives tight closure; eliminates seat leakage. Spring plates in contact with disc faces keep foreign matter out of body. When open, conduit ports through disc give straight-line, unrestricted flow. Full-way or Venturi patterns; sizes 2 to 30 in. Literature sent by mail, or ask your Crane Representative.

CRANE CO.

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KITCHENS • PLUMBING • HEATING

CRANE'S FIRST CENTURY...1855-1955

25 YEARS LEADERSHIP

IN PRODUCTION AND COMPLETION TOOLS

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1 BROWN DUO-PAK PACKER
All purpose packer for *all* producing problems.

2 BROWN SOS J-7 PACKER
Simplest, shortest, safest, retrievable, drillable.

3 BROWN TYPE "A" ZONE SELECTOR
Eliminates outside service crews, zones comingling, killing well and pulling tubing, disturbing packer setting.

4 BROWN SOS DETACHABLE DUAL STRING PACKER
New, simple in design and operation, retrievable. Economical, sets automatically, needs no surface manipulation or tubing weight.

For further information write:

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BROWN IS *FIRST* WITH THE BEST EQUIPMENT

Test proves you can save 83% with aluminum supply lines!

A RECENT TEST conducted by Kaiser Aluminum in Texas showed that the installation of an all-steel drill rig supply line costs $264 per mile! An aluminum pipe and coupler system of the same diameter costs only $44 per mile—or an 83% reduction! Here's why:

The 30-foot lengths of 4-inch Kaiser Aluminum pipe, used in the Texas test, weigh 31 pounds—compared to a back breaking 323 pounds for equivalent steel pipe in common use. This big difference in weight reduced handling time from 52 hours to 12½ hours—a saving of 39½ man hours!

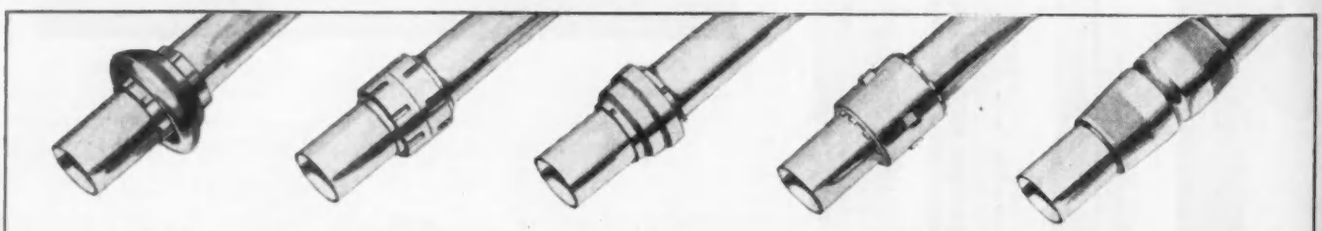
The biggest saving resulted from new quick-connecting couplers that require no welding; one man can easily join pipe sections right in the field without special equipment—in seconds. During the test, a two-man crew reduced connecting and disconnecting time from 69½ hours to 8 hours—a saving of 61½ man hours!

Available in 2, 3, and 4 inch diameters, Kaiser Aluminum petroleum pipe is rolled-formed and induction welded from high-strength aluminum alloy sheet. Design pressure is above 1500 psi, guaranteed test pressure 1000 psi, recommended operating pressure 500 psi, providing a nominal safety factor of 3 to 1. Inside surfaces are clad with high-purity aluminum to increase resistance to corrosion.

For further information, contact the Kaiser Aluminum sales office listed in your telephone directory or any of the fitting manufacturers listed below. Kaiser Aluminum & Chemical Sales, Inc., *General Sales Office*, Palmolive Bldg., Chicago 11, Ill.; *Executive Office*, Kaiser Bldg., Oakland 12, Calif.

Kaiser Aluminum

setting the pace—in growth, quality and service



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Food Machinery & Chemical Corp.
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THESE FIVE tested and approved fittings require no welding: manifolding may be accomplished in the field quickly and easily. Couplers form guaranteed leakproof connections at liquid and gas pressures of 0 to 1000 psi.

"Unto you is born a Savior which is Christ the Lord"

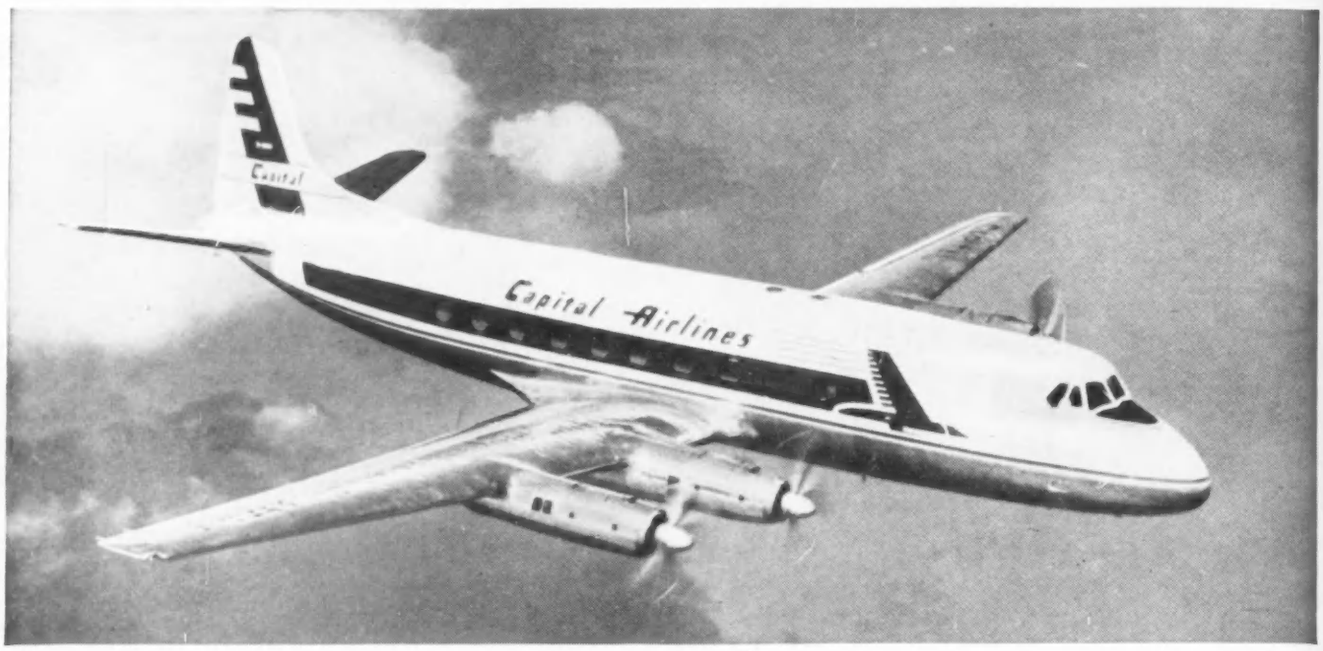
Window by Charles J. Connick Associates (Boston) in St. Paul's Episcopal Church, Salt Lake City. Copies for framing on request

Jones & Laughlin STEEL CORPORATION

SUPPLY DIVISION • TULSA

SHELL REPORTS

A PICTURE ROUNDUP OF SOME ACTIVITIES THAT MADE NEWS OUTSIDE THE PETROLEUM WORLD

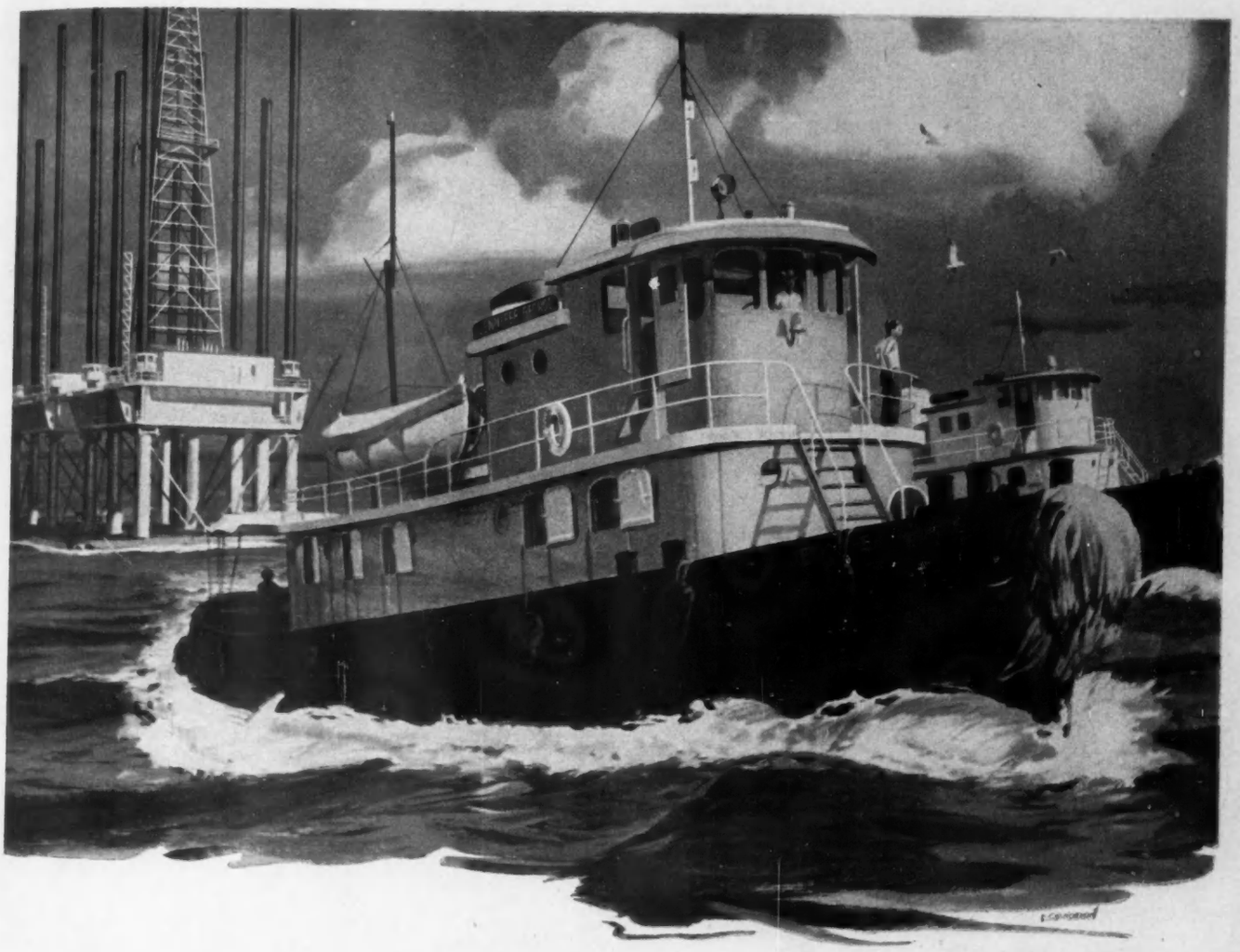


A CAPITAL CONTRACT. To power its new turbo-prop Viscounts, Capital Airlines has selected Shell Oil Company as its supplier of fuel. Throughout flight history, as aeronautical engineers have built new engines and new planes, Shell research has developed the fuels to fly them. Shell Oil Company, leading supplier of aviation fuels to the United States commercial airlines, is helping turbo-prop travel become available for everybody.

ROCK AGER. What Mother Nature takes 10 million years to accomplish, Shell's atom smasher completes in one week. Behind thick walls, particles of rock are bombarded with radiation and thus aged by the first 2-million-volt Van De Graff accelerator in the petroleum industry. In this way, members of Shell's Exploration and Production Research Division are learning more about the age of rock and the origin of oil. Shell's advanced techniques in oil research are a strong investment in today to provide for tomorrow.

HITTING THE ROAD. It's the new method developed by Shell to measure the load-carrying capacity of asphalt. Electronic impulses simulate the jarring effects of traffic, and record the effects of continuous vehicular movement. Without damaging the highways, engineers get a long-range picture of how much a road can take. Shell's research is a step towards a better understanding of road requirements — and to more efficient, longer-lasting highways in the future.

SHELL



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...any time, anywhere

Ample marine horsepower . . . controlled by veteran pilots and engineers who understand the sea . . . is a basic part of every G & H offshore towing contract.

Offshore oil operators have found they can depend on the experienced judgment of licensed G & H crews to provide adequate horsepower for each specific towing job . . . large or small . . . any time, anywhere . . . from a fleet of 18 modern, diesel-powered tugs.

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SEEING THE UNSEEN!

From Tuboscope research has come a line of new instruments, new techniques, new ways to **see the unseen.** Tuboscope research is closely coordinated with field practice. There are no prima donna instruments to fail and tie up your operation. Tuboscope builds for the oil fields and builds to reduce the unnecessary cost of breakdown in tubular goods.
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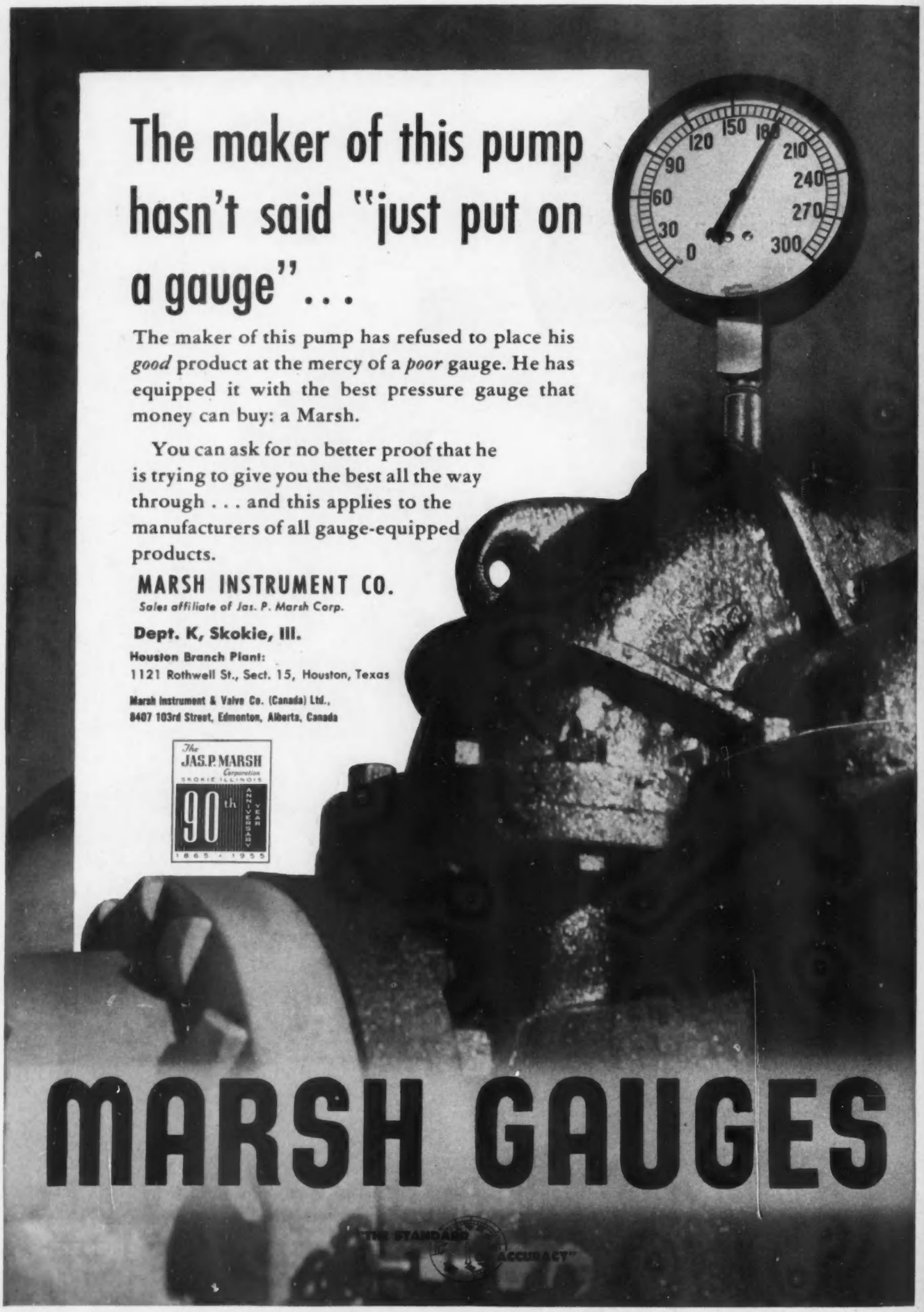
Drilling & Service

ULTRA FINE DIAMOND EQUIPMENT FOR THE OIL FIELD

DALLAS, TEXAS | OFFICES IN PRINCIPAL OIL AREAS


The maker of this pump hasn't said "just put on a gauge"...
The maker of this pump has refused to place his *good* product at the mercy of a *poor* gauge. He has equipped it with the best pressure gauge that money can buy: a Marsh.
You can ask for no better proof that he is trying to give you the best all the way through . . . and this applies to the manufacturers of all gauge-equipped products.
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THE STRONGEST WIRE MAKES THE STRONGEST ROPE... THAT'S WHY ONLY 1105 IS USED IN

ROEBLING

Royal Blue

WIRE 1105 ROPE

1105 WIRE is the strongest and toughest rope wire that has ever been developed.

Royal Blue is a new all-steel wire rope. It's made of 1105 wire—stands up in service—gives you more for your money because it has more to give.

Ask us for the full facts about Royal Blue Wire Rope, or contact your Roebling distributor.

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Subsidiary of The Colorado Fuel and Iron Corporation

JOHN A. ROEBLING'S SONS CORPORATION, TRENTON 2, N. J. BRANCHES: ATLANTA, 934 AVON AVE. • BOSTON, 51 SLEEPER ST. • CHICAGO, 5525 W. ROOSEVELT RD. • CINCINNATI, 3253 FREDONIA AVE. • CLEVELAND, 13225 LAKEWOOD HEIGHTS BLVD. • DENVER, 4801 JACKSON ST. • DETROIT, 915 FISHER BLDG. • HOUSTON, 6216 NAVIGATION BLVD. • LOS ANGELES, 5340 E. HARBOR ST. • NEW YORK, 19 RECTOR ST. • ODESSA, TEXAS, 1920 E. 2ND ST. • PHILADELPHIA, 230 VINE ST. • SAN FRANCISCO, 1740 17TH ST. • SEATTLE, 900 1ST. AVE. S. • TULSA, 321 N. CHEYENNE ST.• EXPORT SALES OFFICE, 19 RECTOR ST., NEW YORK 6, N. Y.

DESIGNED for RUNNING

As part of the Drill String

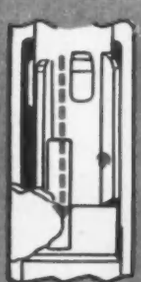
The SHAFFER-WAGGENER BUMPER SAFETY JOINT protects 2 WAYS!

Locked Position (for drilling)

Tripped Position

For safeguarding your drilling well against the hazards of a stuck drill string, nothing surpasses the *two-way* protection provided by the Shaffer-Waggener Bumper Safety Joint. Here's a tool—*specifically designed to withstand the continuous torque and vibration of running directly in the drill string*—that can be relied upon to provide sharp down-jarring at any time the drill string becomes stuck. Or, with equal ease, it provides quick release from the stuck portion for recovery of the string above the tool.

No other tool—or combination of tools—provides the ruggedness, the versatility, the simplicity, the all-around drill string protection you get in the Shaffer-Waggener Bumper Safety Joint!

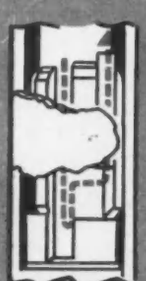


TO RELEASE, *tool is tripped, moving drive keys downward.*

1 **RUN THE TOOL IN THE DRILL STRING**—it's specifically designed to withstand the continuous torque and vibration of modern drilling operations. The tool has been used successfully throughout the world—and at world-record depths. At all depths it provides the extra safety of *double* drill string protection!

2 **TO USE FOR JARRING**, simply slack off weight of approximately 2,000 feet of drill pipe onto the tool. This weight releases the tripping mechanism and strikes a sharp downward blow. Raising the string automatically re-sets the tool for another blow—and repeated blows can be struck as fast as the string can be raised and lowered. *It's as simple and positive as that!*

3 **TO RELEASE**, in the event jarring will not loosen the stuck string, simply trip the tool and apply reverse torque as the string is slowly raised. One-sixth turn of the drive keys rotates them into an unlocking slot so that complete release is obtained by continuing to raise the string.



LEFT TORQUE *then rotates drive keys into unlocking slot as string is raised.*

4 **THE TOOL TRANSMITS TORQUE LOADS** in *either* direction through drive keys—*not* through threads—a *big* advantage over conventional safety joints. In fact, until the definite releasing operations are performed in proper sequence, the tool remains the strongest joint in the drill string. Yet by first tripping the tool, it can be quickly released.

5 **THE TOOL CAN BE RE-CONNECTED** in the hole by simply using the recovered portion at the bottom of a fishing string for mating with the portion left on top of the fish. It's simple, quick!

Added Proof

These typical job records further show the all-around utility of the Shaffer-Waggener Bumper Safety Joint...

3½ MILES DEEP: On this job, the Bumper Safety Joint was released from stuck drill collars at 18,136 ft. (almost 3½ *miles* deep) requiring only 2¾ turns of reverse torque *at the table*. Recovered portion of tool was then attached to bottom of fishing string, run back into hole and connected to fish. After jarring, bit and drill collars were freed, leaving hole completely clean!

3 MILES DEEP: On another job at 16,883 ft. (over 3 *miles* deep) a Bumper Safety Joint being run in the drill string greatly simplified recovery of a parted and dropped string, again leaving hole completely clean!

SLANT HOLES—a problem with conventional safety tools—are no obstacle to the Shaffer-Waggener Bumper Safety Joint. Even directionally-drilled wells with extreme slant are handled in stride.

Send For 8 Page Descriptive Booklet which gives full details on the Shaffer-Waggener Bumper Safety Joint—how it's built, how it operates, and how you can use it for greater safety in your drilling operations. It's free—send today!

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HIGH PRESSURE DRILLING AND CONTROL EQUIPMENT • FISHING TOOLS THAT EXCEL

SHAFFER TOOL WORKS, Brea, California • California Service Shops: Santa Fe Springs and Taft
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FARMINGTON, NEW MEXICO, Shaffer Tool Works, Post Office Box 546
CASPER, WYOMING, Shaffer Tool Works, Post Office Box 1788
EXPORT SALES OFFICE: Shaffer Tool Works, 500 Fifth Avenue, New York, N. Y., U.S.A.

32 years OF OIL TOOL LEADERSHIP

Whatever your product, chances are that Rheem has already developed special linings to protect it for shipment in steel drums

Rheem's experience with hard-to-package products is a matter of record. From acetates to white oils, virtually any bulk-packaged product you can think of is now being shipped in Rheem-built steel drums and pails with special linings.

So you name it. If you have a product you'd like to ship in steel containers, chances are that we've already developed a lining that will protect it. If it's a new product, or one that we've never handled, Rheem laboratories are fully equipped to run tests and recommend a suitable lining. For full information, call our nearest office. Or write to Rheem Manufacturing Company, 1025 Lockwood Drive, Houston 20, Texas or 4901 Jefferson Highway, New Orleans 20, Louisiana.

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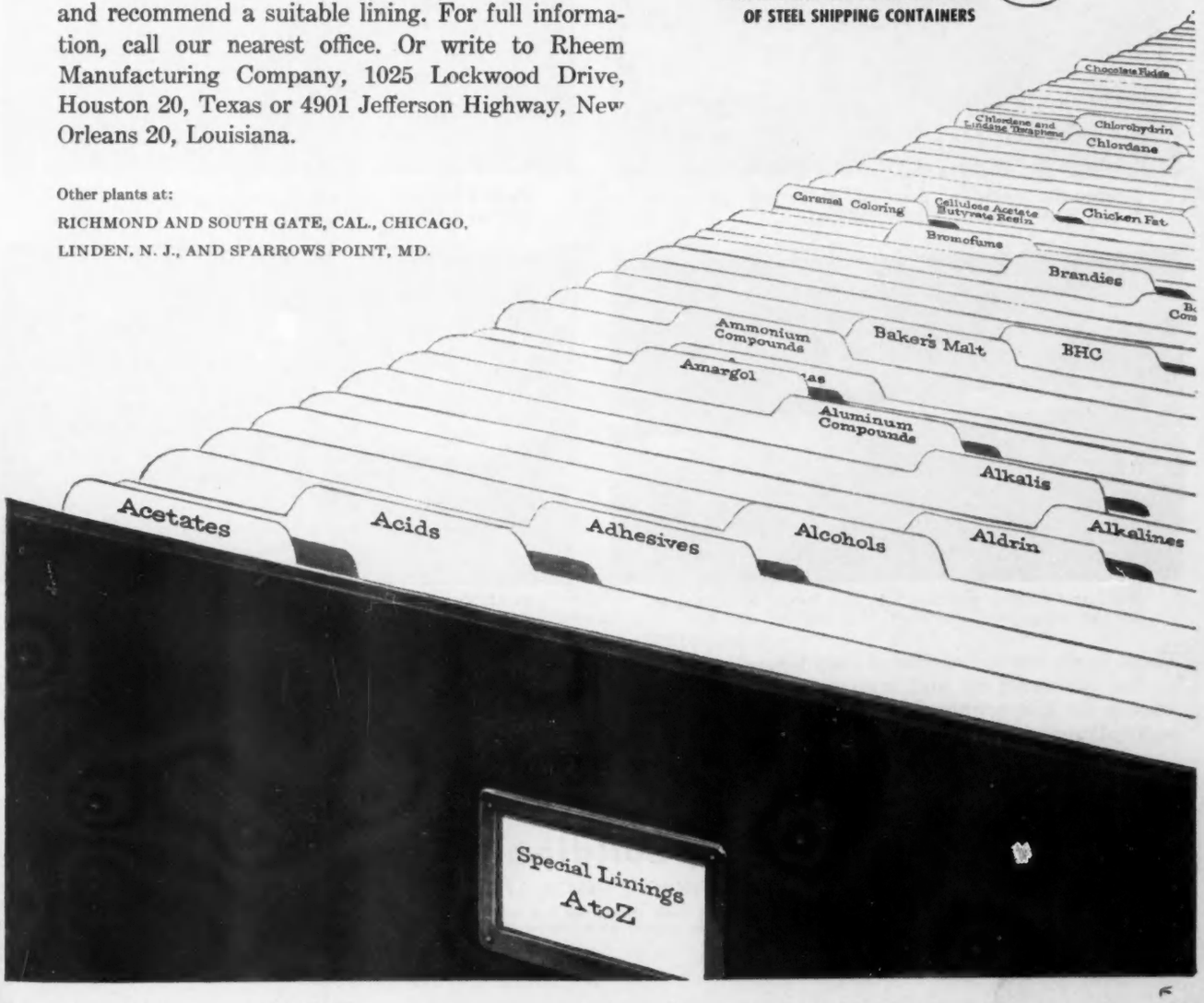
RICHMOND AND SOUTH GATE, CAL., CHICAGO, LINDEN, N. J., AND SPARROWS POINT, MD.

YOU CAN RELY ON

Rheem

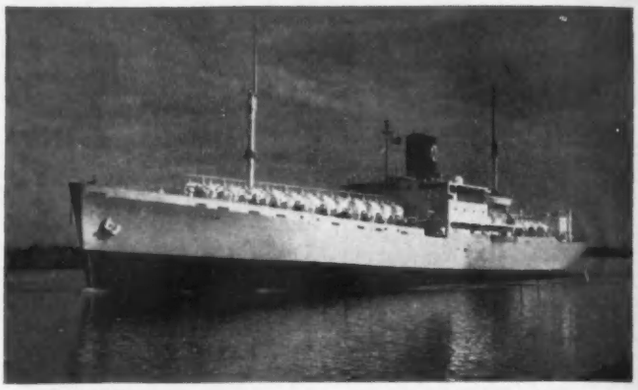
WORLD'S LARGEST MANUFACTURER OF STEEL SHIPPING CONTAINERS



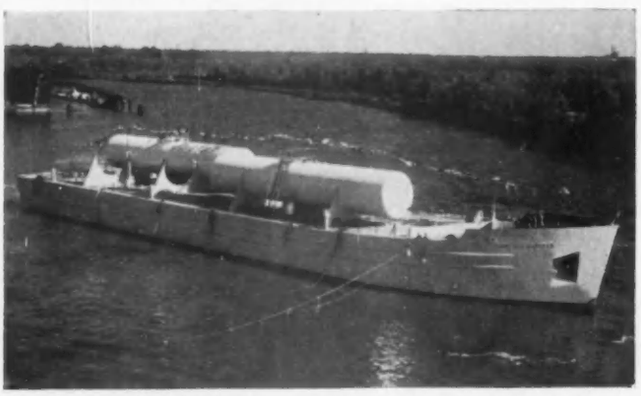
BETHLEHEM AT BEAUMONT

The Nation's Leading Builder and Converter of Waterborne L.P. Gas and Ammonia Vessels

S.S. Natalie Warren, converted to L.P. Gas Carrier. Water capacity 38,000 barrels.



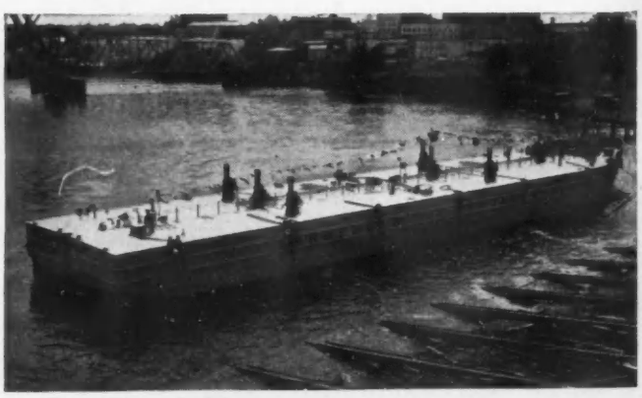
S.S. Ultragaz, converted to L.P. Gas Carrier. Water capacity 17,100 barrels.



Ammonia Mariner, seagoing Anhydrous Ammonia Barge. Water capacity 721,270 gallons.

Esso Viru, oceangoing L.P. Gas Barge. Water capacity 220,000 gallons.

Panama City, rivergoing L.P. Gas Barge. Water capacity 393,000 gallons.



Port Everglades, oceangoing L.P. Gas Barge. Water capacity 550,000 gallons.

These craft are indicative of Bethlehem's activities in the construction and conversion of specialized vessels for the economical and dependable waterborne transportation of L.P. Gas and Anhydrous Ammonia. If you have a problem involving the shipment of these or other petro-chemical products, we may be able to help you. Your inquiries will receive prompt attention.

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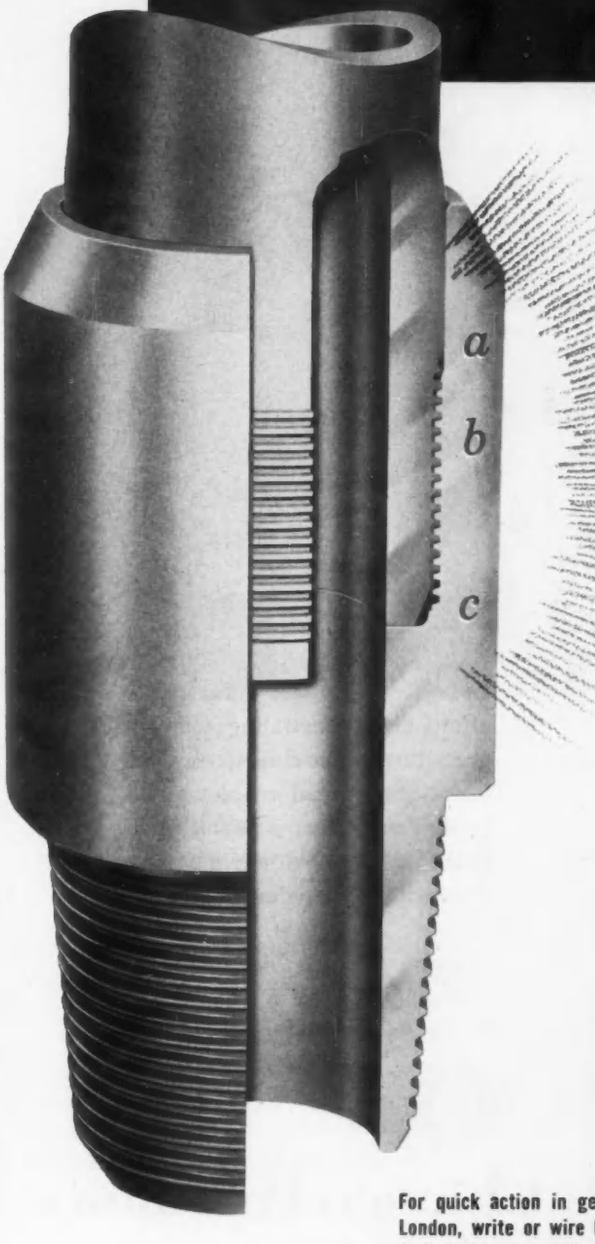
On the Pacific Coast shipbuilding and ship repairing are performed by the Shipbuilding Division of Bethlehem Pacific Coast Steel Corporation

The Reed Super Shrink-Grip FIELD REPLACEABLE tool joint



protects your drilling string investment—against twist offs, against washouts, against leaks

BECAUSE: *a.* The Shrink-Grip "safety area" supports the drill pipe beyond the threaded section . . . and seals against leakage. *b.* Entire thread length is protected by seal at each end. *c.* Fixed landing shoulder assures proper make-up . . . and effects a seal.

extends your drilling string investment to drill "extra wells"

BECAUSE: The "field replaceable" feature of the Reed Super Shrink-Grip Tool Joint enables the operator to: 1. SAVE PIPE by reversing ends before excessive slip wear; 2. SAVE PIPE by replacing tool joint damaged by careless handling; 3. SAVE TOOL JOINT when pipe is bent or crushed; 4. SAVE PIPE when tool joints wear out after they have served their time in giving long trouble-free service.

For quick action in getting complete information . . . in oil areas served from London, write or wire Reed Roller Bit Company, Moorgate Hall, Moorgate, London E. C. 2, England. Cable Address "REEDBIT LONDON."

REED ROLLER BIT COMPANY
HOUSTON 1, TEXAS

THE MARK OF QUALITY

NEW YORK LONDON BUENOS AIRES

5923-A

Rugged Chicago Pneumatic Three Cone Rock Bits are designed to afford deep penetrating action with every turn of the drill stem. Their fast cutting speed enables you to drill more feet a day. They're available in seven different types from soft to exceedingly hard and abrasive formations. *Oil Tool Division, Chicago Pneumatic Tool Company, 5000 U. S. Highway 81 South, Fort Worth, Texas.*

Chicago Pneumatic

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THREE CONE BITS • REAMING BITS • REAMERS • DRILL COLLARS • TOOL JOINTS • SUBS • JUNK BASKETS

It takes a lot of acceptance by the petroleum industry for a service company to put thirty-three markers in a map of the United States — each representing the installation and 24-hour maintenance of a complete, modern core analysis laboratory.

In this case, the thirty-third pin is Core Lab's newest facility — *Liberal, Kansas* — to be opened soon.

As has been the case many times before, the sole reason for establishing a new lab in a particular area is the operators' need for basic formation data — accurately developed by qualified field personnel, interpreted under the supervision of an experienced area resident manager, and made available back at the well site as rapidly as possible. We repeat — without this continued demand for core analysis and its acceptance as a key to the chain of formation evaluation events to follow — we'd have thrown away our box of map pins a long time ago.

There is *no adequate substitute,* either electrical or electronical, for the advantages of directly examining the basic product — the formation and its contents. And the cost of obtaining the best core analysis data available is small when immediate and long-range benefits are balanced against the total cost of reaching an exploratory goal.

Liberal isn't the last. We've got a big box of pins.

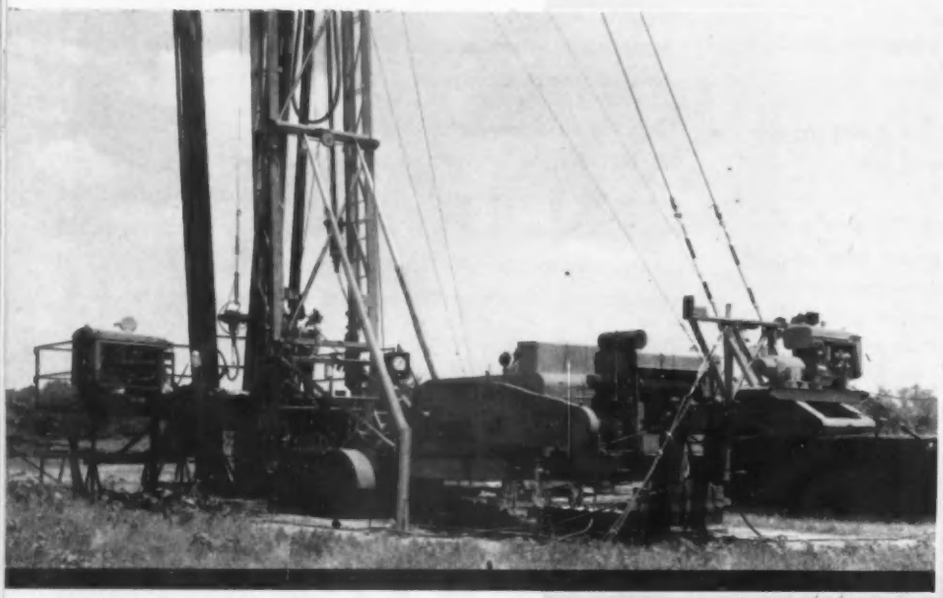
CORE LABORATORIES, INC.
801 CORE STREET, DALLAS, TEXAS

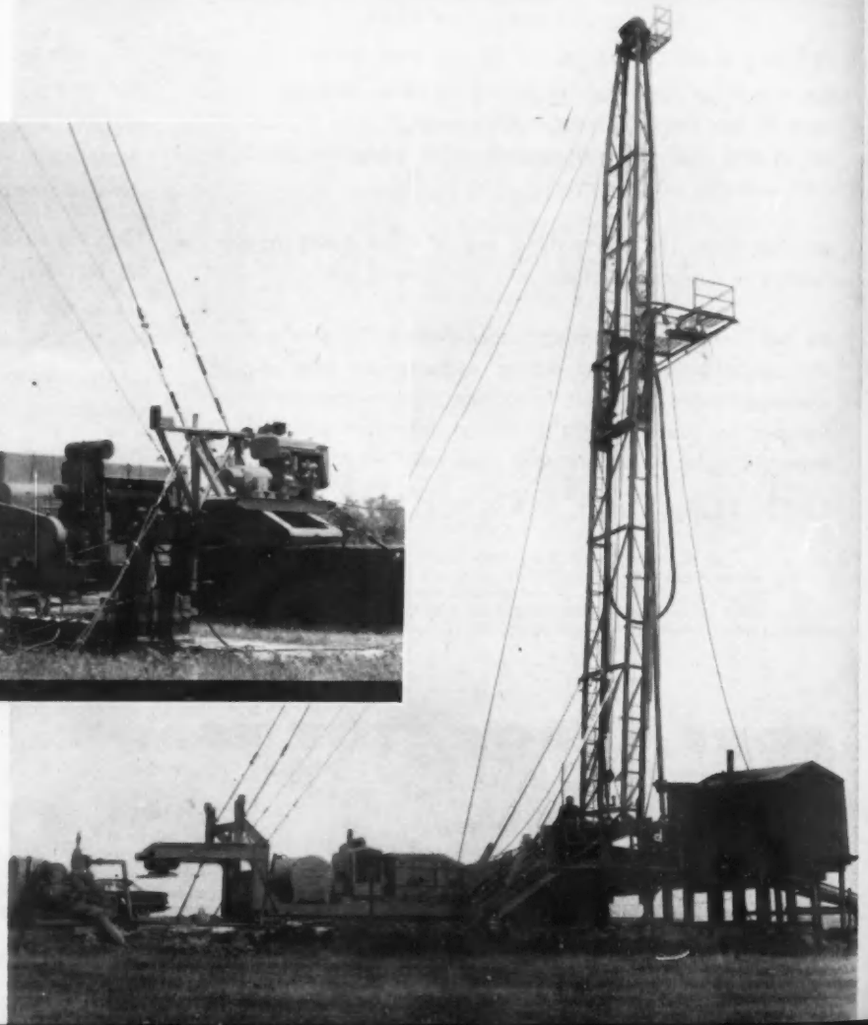
CORE LAB
PETROLEUM RESERVOIR ENGINEERING

DALLAS, HOUSTON, CORPUS CHRISTI, MIDLAND, ABILENE, SAN ANTONIO, TYLER, TULSA, FORT WORTH, WICHITA FALLS, SHERMAN, OKLAHOMA CITY, ARDMORE, BARTLESVILLE, PAMPA, ARKANSAS CITY, GREAT BEND, NEW ORLEANS, SHREVEPORT, HATTIESBURG, LAFAYETTE, DENVER, BAKERSFIELD, CASPER, BILLINGS, WORLAND, STERLING, EL DORADO, LUBBOCK, FARMINGTON, LOVINGTON, MONAHANS, SAN ANGELO, CALGARY, EDMONTON, REGINA.

7 CARDWELL RIGS THAT FIT

1 **Model AL** double drum draw works mounted on two trailers with 100,000-pound mast, makes ideal Slim Hole Rig to 4,000 feet.



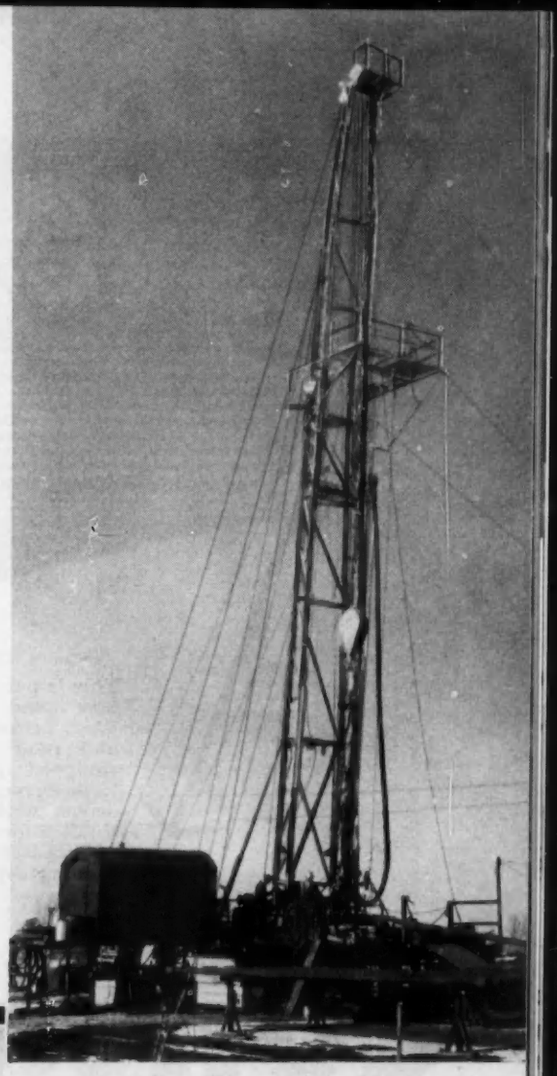


2 **Model K-200** double drum hoist mounted on Model 152 "Trailermast" with separately powered rotary table. Well adapted for 7,000-foot Slim Hole Drilling.

3 **Model AH** draw works mounted on Model 152 "Trailermast." Excellent for drilling to 4,000 feet.

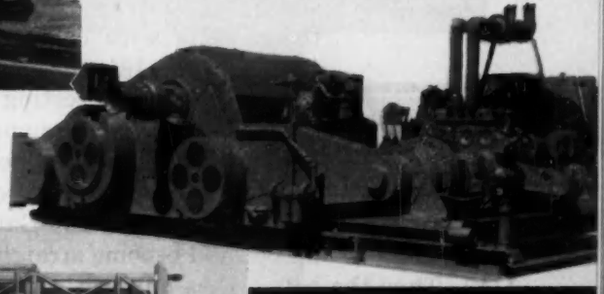
7 NEEDS FOR ANY SLIM HOLE RIG

1. Requires a low capital investment.
2. Light weight reduces first cost and moving costs.
3. Arranged for fast rigging-up.
4. Capable of handling all drilling and completion operations efficiently.
5. Adaptable for a minimum crew.
6. Packaged into a convenient number of small-sized loads.
7. Lowers the daily operating costs.

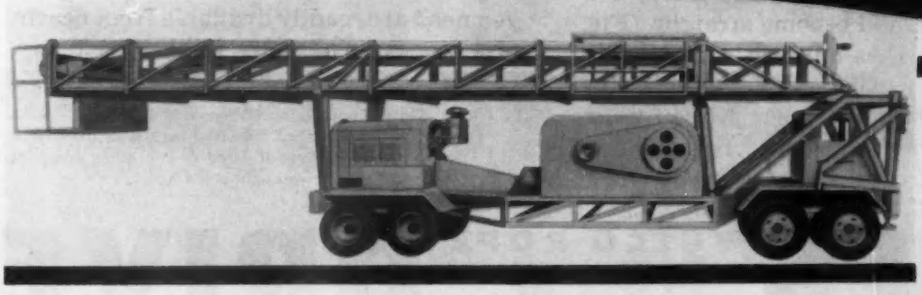


4 **Model L** single drum draw works mounted on Model 151 "Trailermast." Good for 7,000-foot Slim Hole Drilling.

5 **Model S-350** draw works offers unexcelled big-rig performance and quality for 10,000-foot Slim Hole Drilling.



6 **"Trailerig"** is a 10,000-foot, heavy-duty Slim Hole Rig, which is designed for fast moves. A completely packaged unit, giving ultimate flexibility with many built-in features.



7 **Model M-250 "Travelrig"** is a self-propelled 7,000-foot Slim Hole Drilling Rig, incorporating latest improvements in rig and mast design, which cut daily rig costs.

Cardwell Manufacturing Company, Inc.

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CARDWELL

Wichita, Kansas, U. S. A.
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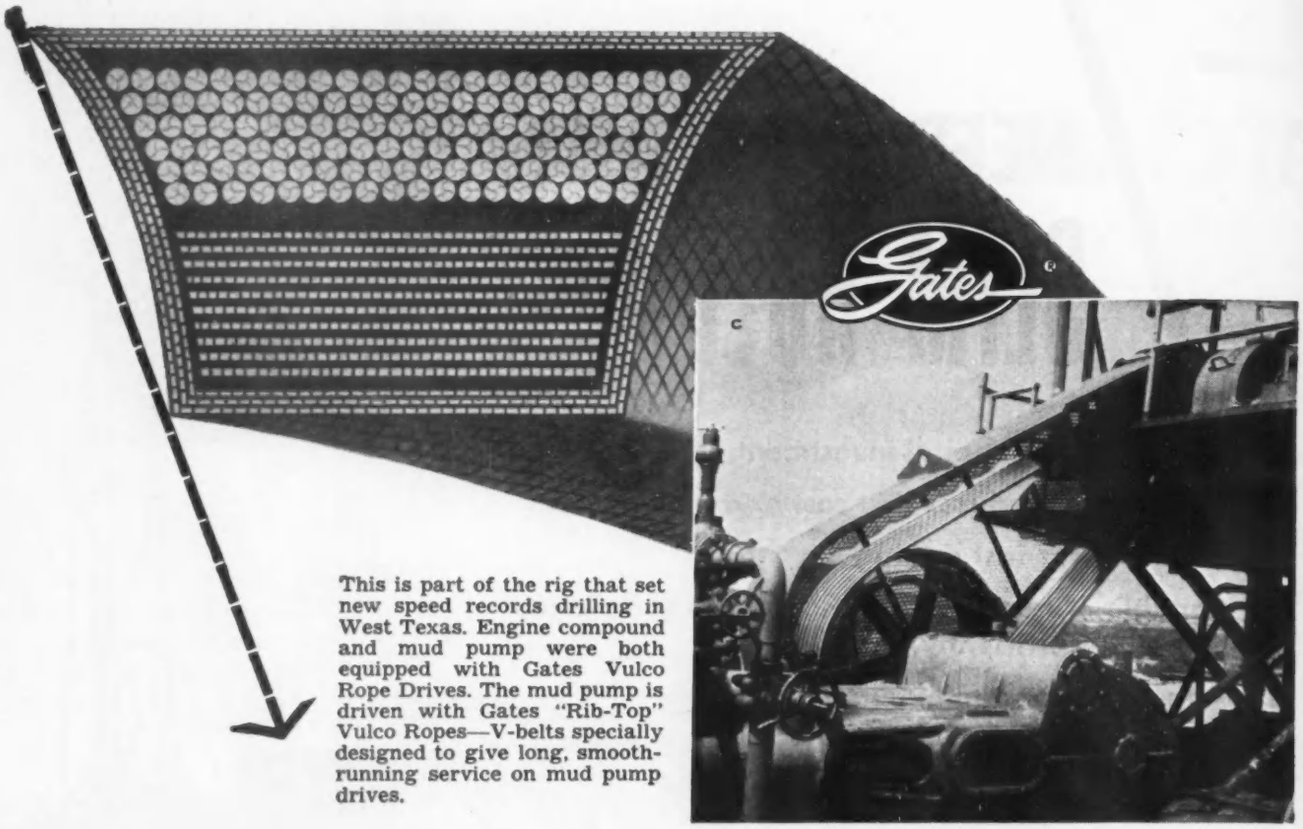


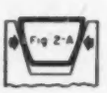
This is part of the rig that set new speed records drilling in West Texas. Engine compound and mud pump were both equipped with Gates Vulco Rope Drives. The mud pump is driven with Gates "Rib-Top" Vulco Ropes—V-belts specially designed to give long, smooth-running service on mud pump drives.

Concave sides keep belt costs down!

Industry is saving thousands and thousands of dollars every year by specifying Gates Vulco Ropes—the V-Belts with *concave sides* (U.S. Pat. No. 1813698).

Here's the interesting reason *why* Gates belts save money:

On the bend around the sheave the *precisely engineered* concave sides (Fig. 1) of the Gates belt fill out and become straight (Fig. 1-A). Thus the belt makes uniform contact with the sides of the pulley. That means sure pulling power and *even distribution of wear*. Longer wear, fewer replacements cut belt costs...reduce down time...contribute to profits.



Simple test proves value of concave sides

Bend a straight-sided belt (Fig. 2) and feel the sides *bulge out* around the bend. The bulging sides prevent the belt from fitting evenly in the pulley groove (Fig. 2-A). Uneven contact causes uneven wear...shortens belt life...increases costs.

Keep belt costs *down* by specifying Gates Vulco Rope Drives—the V-Belt with *concave sides*. Belts you need are readily available from nearby distributor stocks. The Gates Rubber Company, Denver, Colorado—*World's Largest Maker of V-Belts.*

Gates Engineering Offices and Distributor Stocks are located in all industrial centers of the United States and Canada, and in 70 other countries throughout the world.

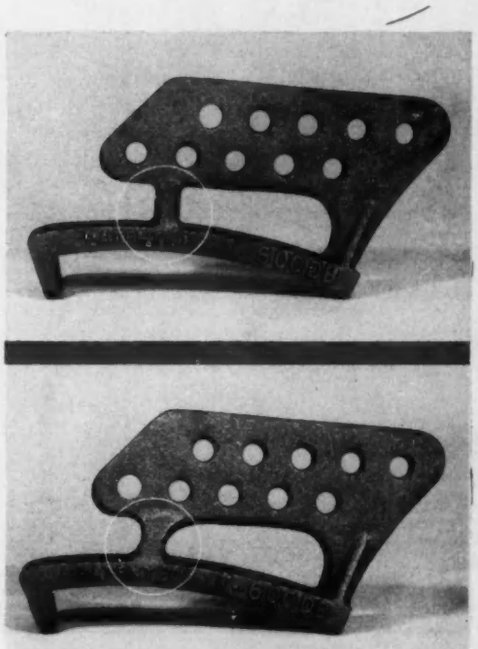
TPA 25-C

GATES VULCO ROPE DRIVES

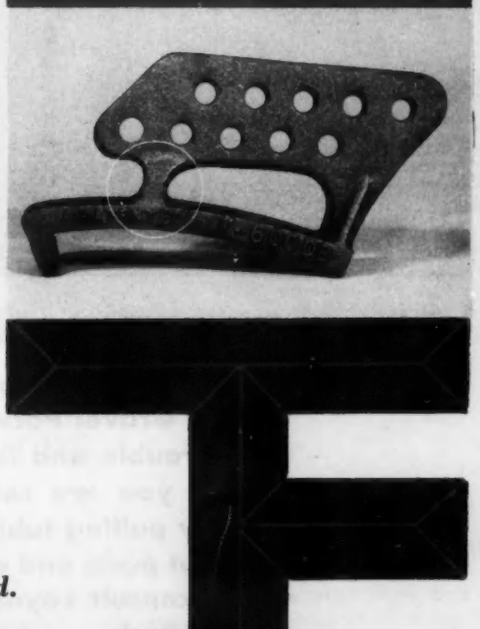
the man from Texas Foundries says . . .

Our engineers increased bracket strength 57% without increasing cost.

A farm implement manufacturer was using a plow sweep bracket of malleable iron. Failures occurred when loads were increased beyond the limits of the original design. Texas Foundries' engineers were called in to help re-design the casting to accommodate the higher loads. (Circled area in upper photo shows where breakage occurred.)



By slightly modifying the original design, strength of casting was increased 57%. Smooth flowing lines of redesigned casting provide uniform stress distribution throughout the part. (See lower photo.)

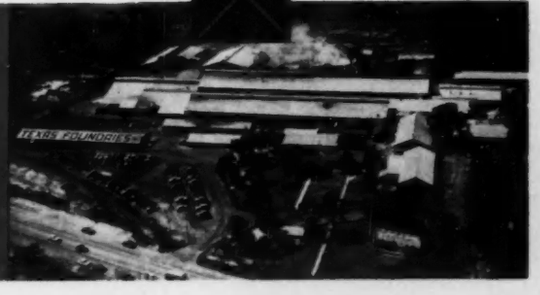


Your inquiries are invited.

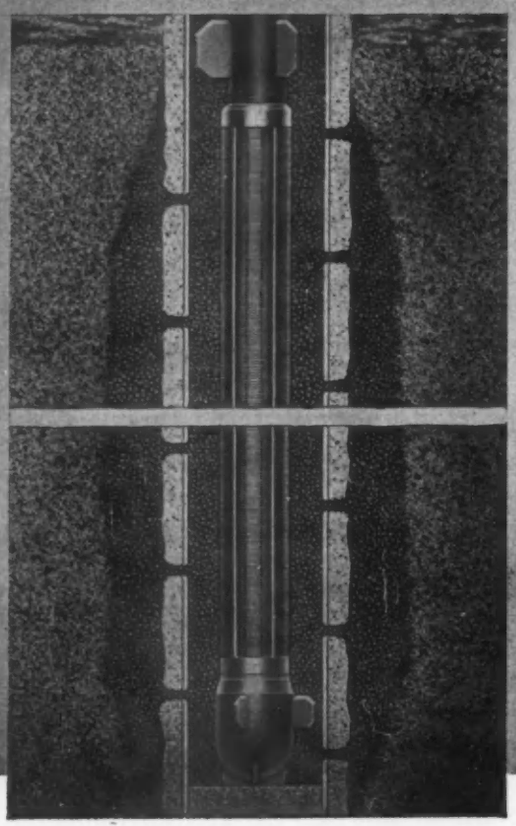
Texas Foundries

Organized for Service

LUFKIN, TEXAS



Eliminates Sand Trouble- Lengthens Well Life



THE LAYNE GRAVEL PACK

More and more operators are having Layne & Bowler Gravel Pack their wells . . . thus eliminating sand trouble and lengthening the life of the well.

If you are confronted with the expense of frequently pulling tubing to replace sanded up screen and sand cut parts and other expense involved in reworking wells, consult Layne & Bowler engineers on the Layne Gravel Pack . . . the modern way of controlling productive sands.

for complete information write

THE LAYNE AND BOWLER COMPANY

General Office & Factory

7800 MARKET STREET HOUSTON, TEXAS

Originators and largest manufacturers of mud valves

Mention mud valves to anyone, anywhere, in the drilling business —most likely they'll say they use Cameron FLEX-SEALS, the tough valves for abrasive service. The FLEX-SEAL has no thin sections to be damaged by rough handling, no delicate adjustments and the sealing surfaces will take an unbelievable beating. Incidentally, the renewable resilient seat is non-extruding—it is retained by a shoulder on the gate, the only such design available. Naturally, this means longer life and fewer replacements. The exclusive swiveling feature makes it a life-long friend to anyone who has tried to make up a tight manifold with ordinary connections.

Like thousands of other operators, you probably enjoy these advantages now. If not, give FLEX-SEALS a try and see why they are on more rigs than any other mud valve in the world today.

Cameron

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THIS IS CAMERON'S 35th YEAR OF SERVICE TO THE INDUSTRY

The Payroll AUDITOR . . . . . .

His Job–to Help You Save Money

The TEIA Auditor's job is to help provide the best possible Workmen's Compensation Insurance service and help you SAVE money.

He periodically checks with policyholders to make sure that workers are covered under the proper classifications and that the policyholder is paying no more than he is supposed to pay for his coverage.

Yes, the Payroll Auditor is a part of the TEIA SERVICE TEAM and it's his job to help you SAVE money.

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Saved and Returned to
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TEXAS' *Largest Writer of*
WORKMEN'S COMPENSATION

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TEXAS EMPLOYERS INSURANCE ASSOCIATION
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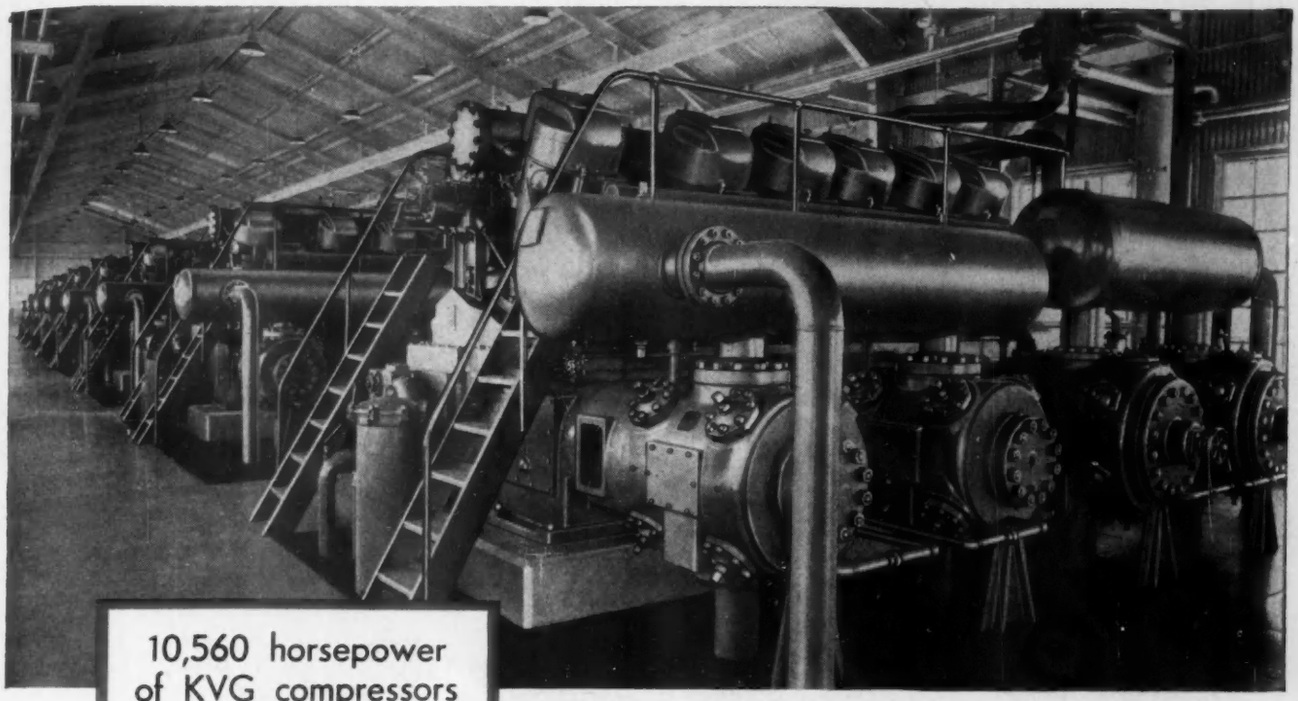


10,560 horsepower of KVG compressors at Permian Basin Pipeline Company

These eight Ingersoll-Rand KVG gas-engine compressors provide a total of 10,560 horsepower for a gas compression station of the Permian Basin Pipeline Co., a subsidiary of Northern Natural Gas Company. Each machine consists of a 12-cylinder, V-type, four-cycle gas engine with four compressor cylinders mounted on the same frame and driven from a common shaft.

On any service
I-R Gas-Engine Compressors
offer two basic advantages

Wide load fluctuations are unavoidable in many compressor applications. That's why the *flexibility* of I-R FOUR CYCLE gas-engine compressors is a big asset. They always deliver smooth, steady power all the way from no load to full load and at any speed from half to full rated rpm.

The second basic advantage is in the *compressor end.* Here the extra dependability and the trouble-free performance of I-R job-engineered cylinders and valves add up to exceptionally low maintenance expense. This has been proven repeatedly in hundreds of installations covering all types of air and gas compression requirements.

Ingersoll-Rand four-cycle gas-engine compressors are available in sizes from 110 to 2000 horsepower. Call in your I-R representative when planning your next installation. His experience can save you time, effort and expense all along the line.

Ingersoll-Rand

6-267 ♥ 11 BROADWAY, NEW YORK 4, N. Y.

Thermoid Powerflex Rotary Hose is built to go "all the way" in deep hole drilling!

33 miles of high tensile steel wire forms the cable that is precision wrapped, counter wrapped and imbedded in every length of Powerflex. Oil and abrasion resistant Neoprene tube and cover are reinforced with impregnated multi-ply woven fabric.

Patented Full-Flow couplings of forged steel are an integral part of the cable assembly... permanently secured *before* the hose is wrapped and cured. They positively cannot leak or pull off for the life of the hose.

Powerflex is proof-tested to 5000 psi before shipment . . . will withstand the highest pressures. Order Powerflex from your nearest supply store or one of the following Thermoid Warehouses:

Houston, Texas — Oklahoma City, Okla.
Casper, Wyo. — Nephi, Utah
Los Angeles, California

Thermoid

Powerflex Rotary Hose • Trioflex Slim-Hole Rotary Hose • Mud-Flo Slush Pump Hose • Flexible Discharge Units • F.H.P. and Multiple V-Belts • Oil Country Flat Belting

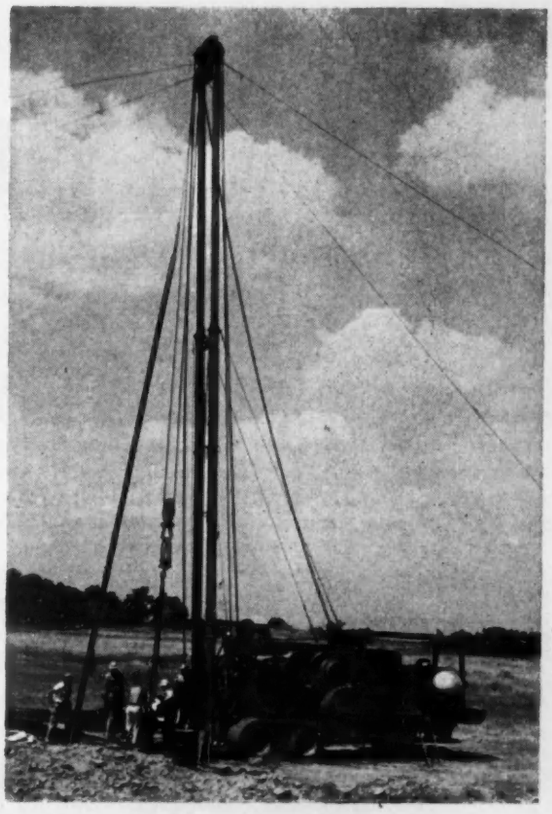
Wire Line Turn Backs • No-Wip Line Savers • Stuffing Box Rings • All Types of Hose • Molded Specialties • Brake Blocks

Thermoid Company • Offices & Factories: Trenton, N. J. Nephi, Utah

Here Is Why
WALKER-NEER SPUDDERS
STAND UP LONGEST

And Have the HIGHEST

RE-SALE *VALUE*



1. BALANCED DRUMS. Every drum is precisely balanced to eliminate destructive vibration. Note—and compare—the smooth, quiet running of drums on Walker-Neer Spudders.

2. JAR-FREE DRILLING ACTION. Walker-Neer's "Tor-Shock" (Rubber Torsion) Shock-Absorber not only provides unequalled "snap," for faster drilling, but provides a "bottomless cushion" against rig-shaking jar.

3. V-BELT AND CHAIN DRIVES. All Walker-Neer models have either V-belt or chain drive, or a combination of the two. Parts replacements are few and far between . . . quickly installed . . . and relatively low in cost. All belts, chains, and clutches have guards that prevent damage, keep them clean, reduce maintenance problems.

4. ALL BALL AND ROLLER BEARING CONSTRUCTION. All drums, masthead sheaves, clutches, and adapters are mounted on sealed roller and ball bearings . . . greatly reducing the frequence of lubrication, and increasing rig life.

5. VISIBILITY. All working parts can be observed from the driller's position—a big factor in preventive maintenance.

6. PRE-DELIVERY TEST RUN AND SERVICING. Every Walker-Neer Spudder is given a thorough test run, prior to delivery, to assure perfect functioning of every part. At this time, the rig is completely serviced, and every fitting is greased.

7. INSTRUCTION TO OPERATORS. A Walker-Neer service man gives thorough instruction to your operators on all details of operation, lubrication, and maintenance . . . and the Walker-Neer organization takes a continued, active interest in your rig.

WALKER-NEER

MANUFACTURING COMPANY, INC.

P. O. BOX 2490 WICHITA FALLS, TEXAS

DISTRIBUTORS: Oil Well Supply Division • Bovaird Supply Company • Jones & Laughlin Supply Division • Mountain Iron and Supply Company • E. D. Taylor Company • Acme Well Supply (exclusive export agent except on North American Continent)

First offshore use New Electro Drilling Rig

Phillips Petroleum Company's rig, working in the Gulf off the Louisiana shore, is the first offshore application of the new Electro-Motive Drilling Rig Power Plant.

The 1,750-horsepower system, comprising two 8-cylinder, 875-h.p. Diesel-Electric generating units, is being used on a self-contained platform, with the General Motors units conveniently housed on the drilling platform.

Saves high-cost platform space

The Electro-Motive units enable Phillips to save several hundred square feet of high-cost platform space that would have been necessary with a Diesel-mechanical rig. The Diesel-Electric generating units eliminated the need for alignment with draw works, rotary table or mud pumps which would have been required in a mechanical-type rig.

Flexible electric cable from the basic generating units are connected to seven Electro-Motive motors which supply power for the rotary table, draw works and two mud pumps. The draw works is a steam type with a jaw clutch now powered by two Electro-Motive 625-h.p. direct current motors.

Quick setups—easy connections

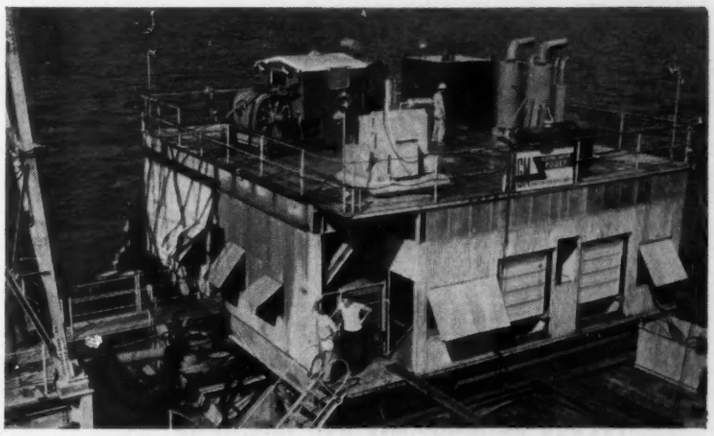
These units are identical with the two 8-cylinder Electro-Motive engine-generator sets used earlier this year on a land rig of the Offshore Company near Houma, La., and now drilling a second well in Louisiana. *In a test on this rig, simulating engine failure, cables were completely reconnected in only seven minutes.*

These flexible units offer the petroleum industry an entirely new concept in a Diesel-Electric drilling rig—the smoothness of steam with none of its disadvantages. A compact, lightweight package with all components engineered, built and backed by *one* manufacturer, the Electro-Motive system features simplified control and rugged dependability at a cost far below that of previously built Diesel-Electric rigs and comparing favorably with Diesel-mechanical rigs.

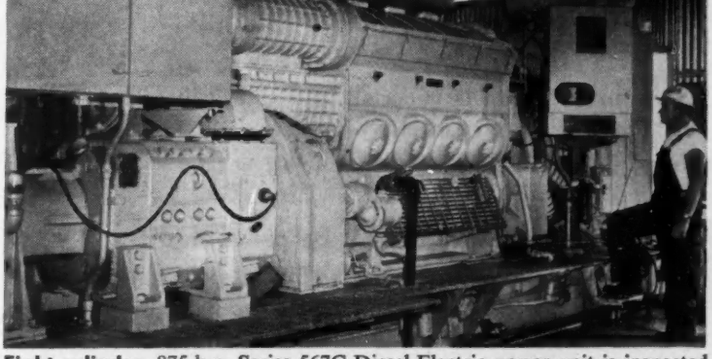
For further information, write or call your nearest Electro-Motive representative. Electro-Motive Division offices located in: New York City, Chicago, Jacksonville, St. Louis, Tulsa and San Francisco.

of -Motive Power Plant

Phillips Petroleum Company rig making hole 35 miles out in the Gulf of Mexico—with 1,750-h.p. Electro-Motive system



Power for Phillips Petroleum Company rig 35 miles out in Gulf of Mexico is supplied by 1,750-h.p. Electro-Motive Diesel-Electric generating system housed in building at right. Two 8-cylinder 875-h.p. units supply power for seven electric motors to run draw works, rotary table and mud pumps, saving several hundred square feet of high-cost platform space.



Eight-cylinder, 875-h.p. Series 567C Diesel-Electric power unit is inspected by tool pusher, M. J. Johnson. Extremely compact and light in weight, these rugged units are individually skid-mounted for easy, fast setups and economical moves. Old-timers in the oil fields have expressed surprise at the engine's quick starting, one of the unique features of its time-proved two-cycle design.

Driller C. Reeves of Franklin, La., at controls of the big Phillips Petroleum Company rig. The new plant brings to oil-well drilling the long-sought advantages of extremely high torque at extremely low speeds. The Electro-Motive system provides instantaneous control and it is offered at a price hitherto untouched by other equipment of this type.

Features of Electro-Motive Drilling Rig Power

Completely Integrated Design—Each of the major components designed and built to work together—*one* manufacturer—*one* source of service responsibility.

Maximum Portability—All components on skids, with weight reduced to a minimum. Units are ruggedly designed to withstand moves. No position problem—slashes setup time.

Unmatched Flexibility—Transmission of power is by cables. Slip connections on all cables and controls are so simple anyone can handle them.

Simplified Control—Centralized position for all controls for driller's convenience. Continuously variable draw works speed control without gearshift or reconnection.

Lower Drilling Costs—Lower first cost and lower cost per well drilled. Smooth electric power—flexible control—speeds drilling, means less down-time.

COMPLETE NATIONAL SERVICE AND PARTS AVAILABILITY

ELECTRO-MOTIVE DIVISION · GENERAL MOTORS

La Grange, Illinois • In Canada: GENERAL MOTORS DIESEL, LTD., London, Ontario

World's Largest Builder of Heavy-Duty Diesel Engines and Electric Traction Equipment

Be sure of your directional surveys

...use permanently non-magnetic

SERVCO "K" Monel Drill Collars

No iron...yet stronger than steel

Every survey record is important and with drill collars of "K" Monel alloy you can plot your course with confidence.

Yes, you can be safe whether your target be a lease line, a fault play, or the avoidance of another well.

Can stray magnetism be prevented?

The survey drill collar itself must be free of spot magnetism. You can eliminate such a possibility with Servco Drill Collars made of "K" Monel* age-hardenable nickel-copper alloy. These collars are iron-free and permanently non-magnetic in oil field use.

You can avoid another major source of error, drill string magnetism. Since "K" Monel is not subject to induced magnetism from the drill string, it's simply a matter of using collars of proper lengths, incorporating compass spacings worked out by Servco Engineers.

Is drilling speed affected?

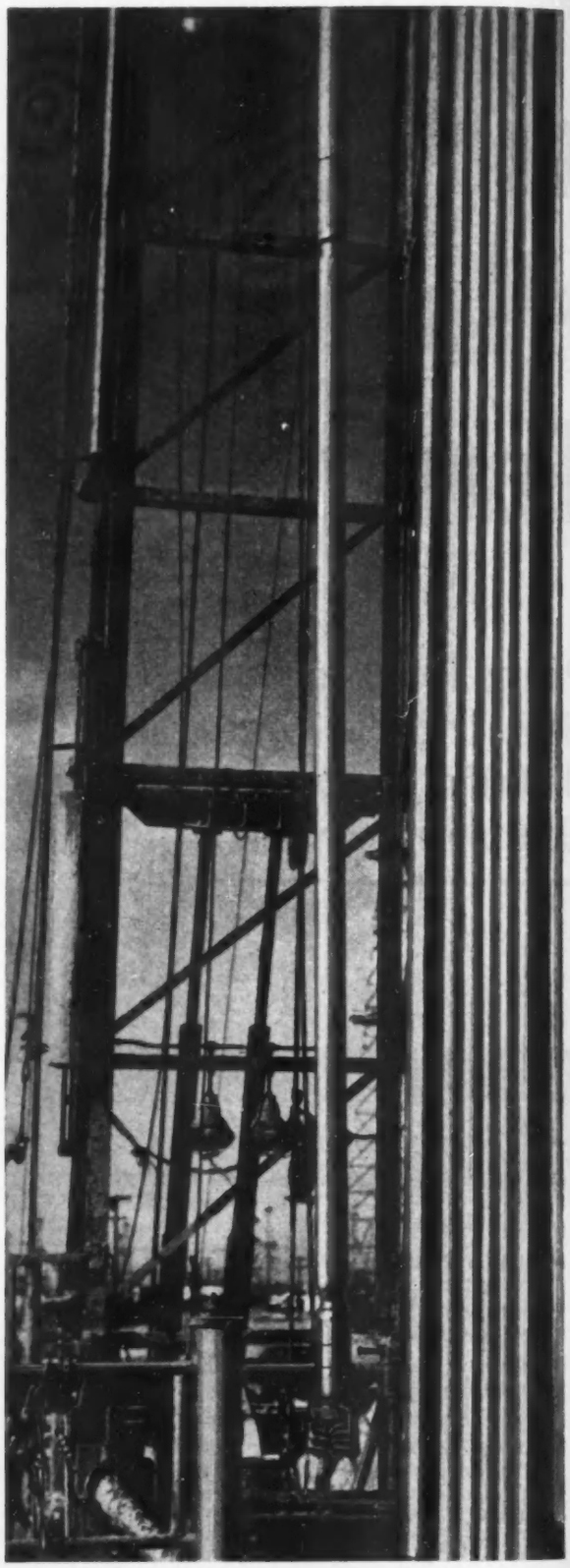
Servco Drill Collars made of "K" Monel alloy *save* rig time.

For one thing, the high density of this age-hardenable nickel-copper alloy puts extra weight right above the bit. Just where you want it. For another, you can use your most efficient bit . . . since there's no need to round trip to take survey readings. Finally, you can really push a "K" Monel Collar. It's stronger than steel; corrosion-, wear- and abrasion-resistant.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street New York 5, N. Y.

INCO
TRADE MARK

Makes 32 sizes and types of "K" Monel Drill Collars — During nine years of making and distributing directional drilling equipment, Servco has developed a complete range of standard and special "K" Monel Drill Collars, adapted to either top or bottom landing methods. Stocks include special types such as Gilligans, drill pipe singles, pup joints. You can order diameters from 3½ in. O.D. to 9½ in. O.D., lengths from 14 ft. to 33 ft., tool joints of either welded or super shrink grip type. Just contact your nearest Servco office.



Offshore drilling must be accurate. Permanently non-magnetic Servco "K" Monel Drill Collars help make it so . . . prevent hidden survey errors caused by magnetism from the drill string.

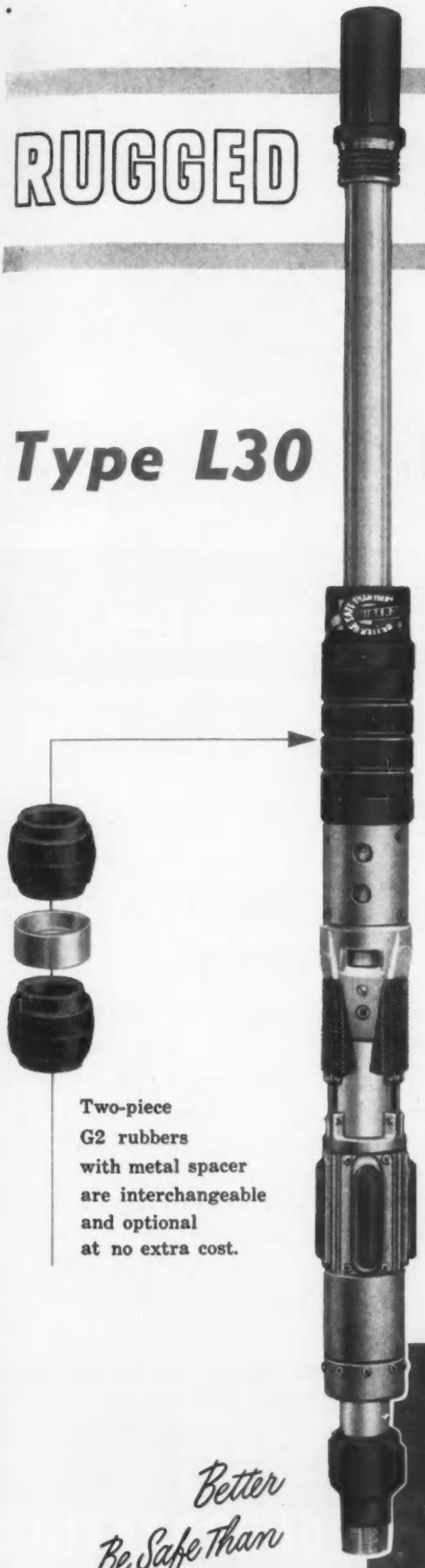
* * *

Home office of The Servco Company is in the Security Bldg., 9th floor, Long Beach 2, California. Other offices in Bakersfield, Ventura, Houston, Lafayette, Oklahoma City, Denver, Casper.

*"K" Monel is a registered trademark of The International Nickel Company, Inc., which is applied to age-hardenable nickel-copper alloys produced and marketed by it.

RUGGED AND RELIABLE

GUIBERSON'S
Type L30 Deep Well Packer



Two-piece G2 rubbers with metal spacer are interchangeable and optional at no extra cost.

For deep well work with high temperatures and pressures, use Guiberson's dependable L30 Packer. It will give you long valve travel (30 inches) with minimum overall length at no extra cost. You can pull the L30 surely and safely. The fast-action automatic latch, protected by a positive anti-lock device that assures ready release, snaps easily into latched position. Tough, long-wearing friction pads supply ample drag. Packing rubbers of advanced design will not vulcanize to the casing wall. All these features are available on the L30 or the L8 with 8" valve stroke in a wide range of casing sizes. For circulating *above* the packer, Type L30P or L8P with perforated mandrel is available.

Better Be Safe Than Sorry

THE
GUIBERSON
CORPORATION

ESTABLISHED 1919 • DALLAS, TEXAS, U. S. A.

Sold By Leading Oil Field Supply Stores Everywhere

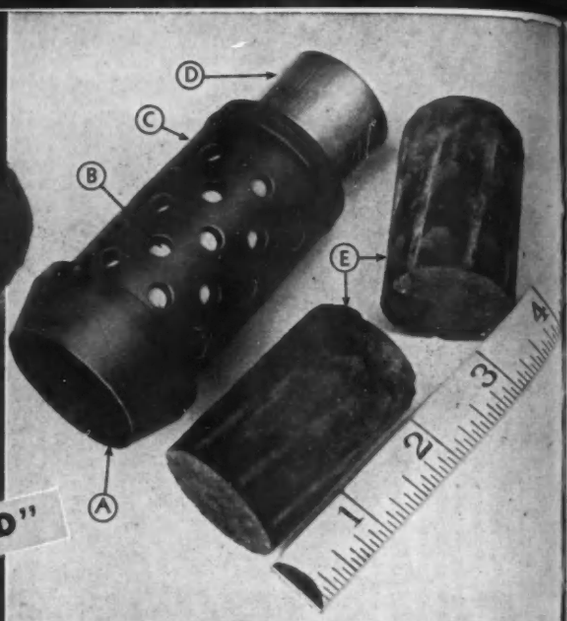
PGAC JUMBO
Side-wall Core Samples...

"SO ROUND....

SO FIRM....

SO FULLY PACKED"

(WITH APOLOGIES TO A GOOD SMOKE!)



PGAC Side Wall Coring Chamber. A—Cutter. B—Mud Extrusion Ports. C—Core Barrel. D—Powder Chamber and Retrieving Cable Housing. E—Note large size of PGAC core samples.

Why YOU should always call in PGAC to take your core samples....

1. Each PGAC core sample is taken from a *precision-determined* depth . . . because the exact position of each core barrel is *pin-pointed* by the superior accuracy of PGAC's S.P. curve on their electrical log.

2. Identification of each PGAC core sample is *positive* . . . because the firing of each core barrel is controlled by a completely separate electrical circuit . . . because a foolproof indicating circuit shows when each barrel is fired, and *which barrel* is fired . . . and because an automatic counter indicates the firing of each barrel.

3. Time after time, oil operators are amazed to see PGAC's *100% recovery of samples* — a sample in every core . . . because of the superior firing power of PGAC guns . . . because of the unequalled dependability of PGAC controls . . . and because of the 2500 lb. tensile strength cables used for *certain* barrel recovery

4. Laboratory analyses of PGAC core samples are invariably facilitated and *more accurate* fluid determinations made possible . . . because of the larger, over-size samples obtained from PGAC's *JUMBO* core barrels . . . and because each sample is *"so round, so firm, so fully packed"!*

So, when *you* decide to sample your side-walls — *always* decide on a *JUMBO* Coring job by PGAC. Then you'll always be able to sit down, light a good smoke, and relax. We'll be looking for your call!

PGAC-538.

PERFORATING GUNS ATLAS CORPORATION

Houston, Texas Telephone REpublic 4-1651

General Offices and Main Plant: 7730 Scott Street — Sales Office: Melrose Building

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"Million-dollar chunk of steel" being floated to offshore position, where it will be settled on the bottom by filling the pontoons with water

Sheffield Steel products "go to sea" in history's biggest treasure hunt

Talk about sunken treasure! Under the coastal waters of Texas and Louisiana lie oil pools estimated at nearly half the total of recoverable reserves in the U. S.

Sheffield was ready when the Tidelands Bill gave the treasure hunt signal. Ready with steel for building the drilling platforms – man-made "islands" as far as 30 miles at sea. Ready with bolt and nut products; high-strength structural bolts; structural steel and merchant shapes; plates for barges and pontoons; and numerous other steel items which implement the big search for new oil.

Big as it is already, offshore oil production is barely out of the pioneering stage. Its future is tremendous. Sheffield is geared to produce the steel that's needed. If you're in any part of the oil business, you have an interest in knowing how Sheffield quality steel and Sheffield's strategic location provide important advantages. Get the facts from your nearest Sheffield office.

SHEFFIELD

ARMCO

Quality Steel for the oil industry

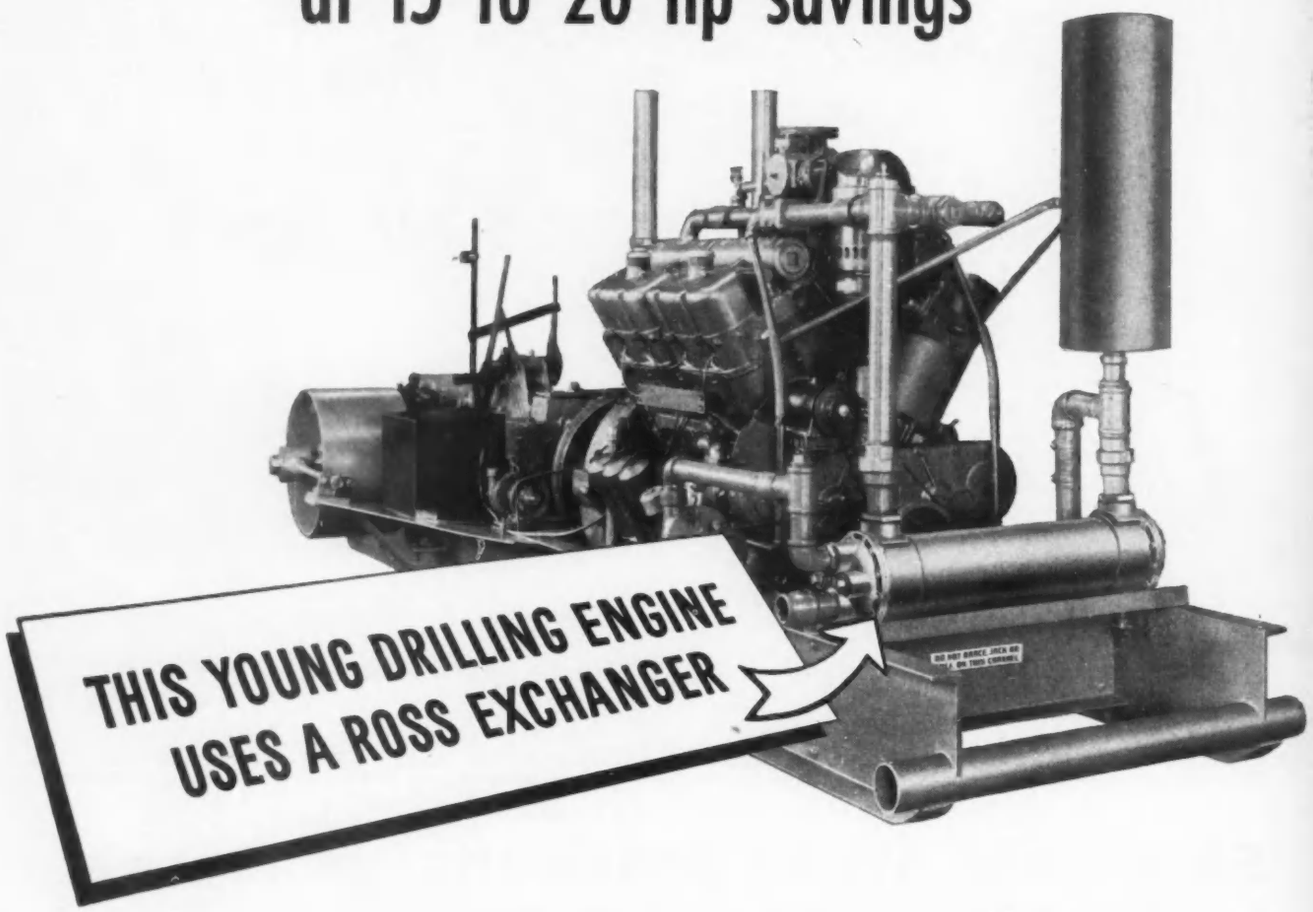
SHEFFIELD STEEL

DIVISION

ARMCO STEEL CORPORATION

SHEFFIELD PLANTS: HOUSTON • KANSAS CITY • TULSA

Jacket water kept cool at 15 to 20 hp savings



● Drilling a wildcat gas well to an ultimate depth of 12,000 ft. requires all of the 280 hp that this Young Drilling Engine is capable of developing.

Had Young Engine Corporation, its maker, used a customary radiator and fan to cool the jacket water of the 8-cylinder Le Roi gasoline motor which powers this equipment, from 15 to 20 hp would be consumed. The customer, a well known eastern natural gas company, felt that this power loss could not be afforded.

Young's solution: a power-saving Ross Type BCF Exchanger. Compact and of all-copper and copper alloy construction, this fully standardized, pre-engineered unit is today keeping engine jacket water at the most effective temperature level, even under most rigorous conditions.

Similarly, Ross Exchangers are effecting economies of one kind or another for a great variety of machines — Diesels, compressors, turbines, speed increasers, hydraulic equipment, to name a few — as oil or water coolers, or as both. To obtain the details of their design and construction that have earned them their leadership, request new Bulletin 1.1K5.

KEWANEE-ROSS CORPORATION
DIVISION OF AMERICAN RADIATOR & STANDARD SANITARY CORPORATION
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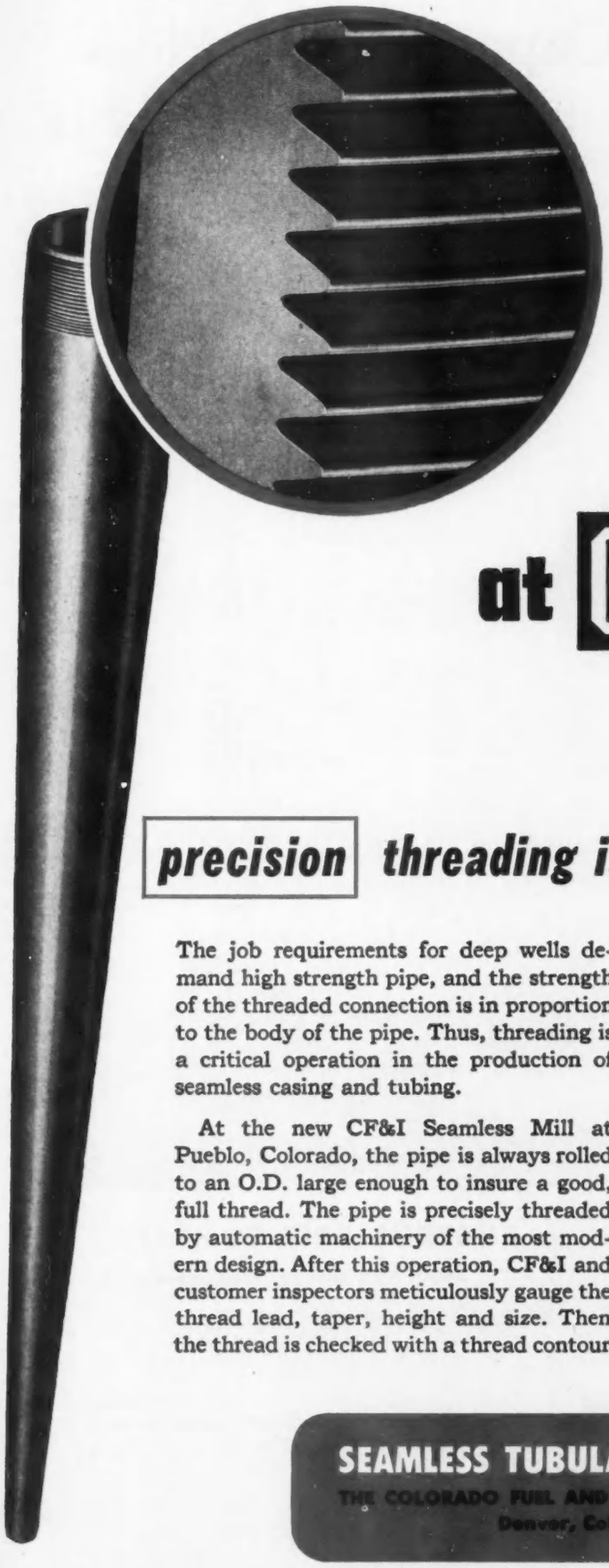
Serving home and industry: AMERICAN-STANDARD • AMERICAN BLOWER • CHURCH SEATS & WALL TILE • DETROIT CONTROLS • KEWANEE BOILERS • ROSS EXCHANGERS • SUNBEAM AIR CONDITIONERS



at CF&I Seamless Mill

precision threading is checked microscopically

The job requirements for deep wells demand high strength pipe, and the strength of the threaded connection is in proportion to the body of the pipe. Thus, threading is a critical operation in the production of seamless casing and tubing.

At the new CF&I Seamless Mill at Pueblo, Colorado, the pipe is always rolled to an O.D. large enough to insure a good, full thread. The pipe is precisely threaded by automatic machinery of the most modern design. After this operation, CF&I and customer inspectors meticulously gauge the thread lead, taper, height and size. Then the thread is checked with a thread contour microscope, an instrument that determines absolute accuracy of thread angle and form. Finally, thread lubricant is applied to all threads, the couplings are bucked on power-tight and thread protectors are put on both ends of the pipe.

CF&I Seamless Oil Country Casing and Tubing meet API STD 5A specification and are available in sizes from 2⅜" through 9⅝" O.D. CF&I has complete control of the quality of the materials it uses, and production is carefully supervised through every step of manufacture to make sure that CF&I products meet the exacting requirements of the petroleum industry.

SEAMLESS TUBULAR PRODUCTS
THE COLORADO FUEL AND IRON CORPORATION
Denver, Colorado

CF&I

3205

Mobility In Big Capacity Spudders *Pays Off With Faster Well Completions*

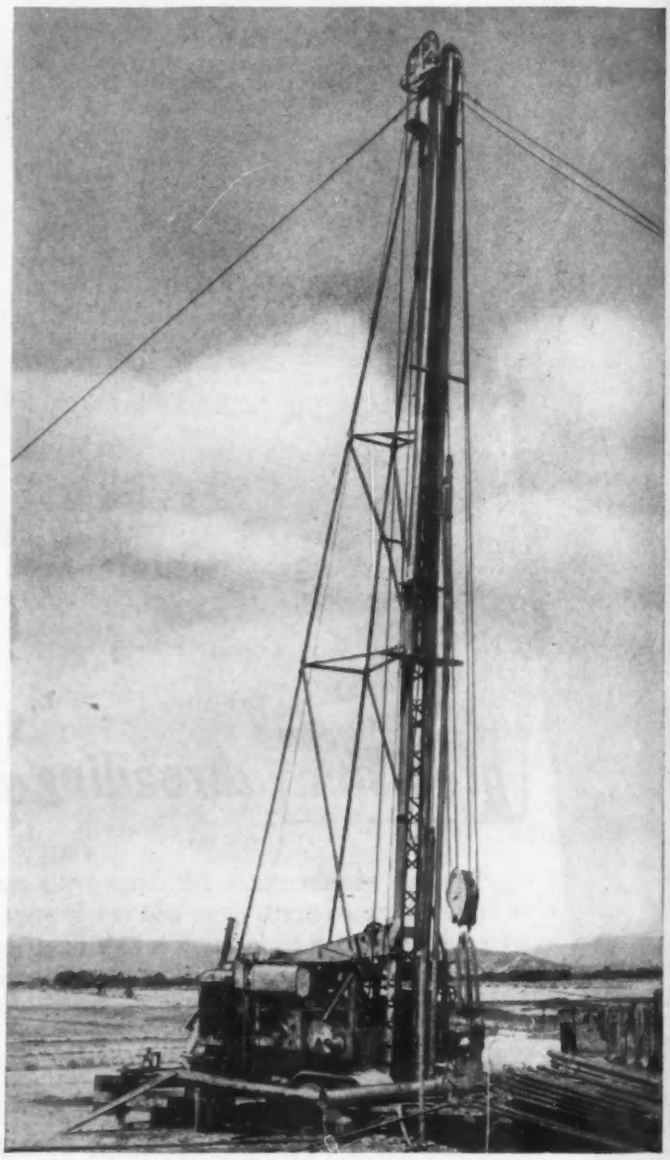
Compactly Built Tandem Axle Mounting Speeds Between-Job Moves

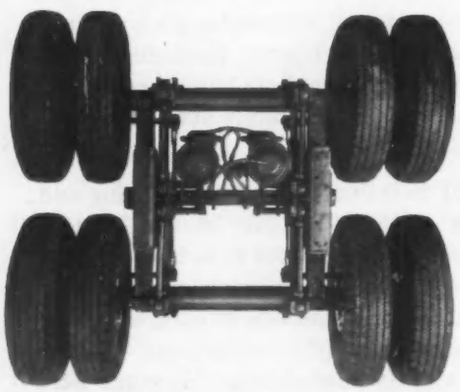
Despite their size, Bucyrus- Erie 36-L and 48-L spudders can be moved readily. Mounted as a semi-trailer with tandem rear axle, they can be transported as a single compact unit — at normal highway speeds. This means more time spent on productive drilling, greater profits for you.

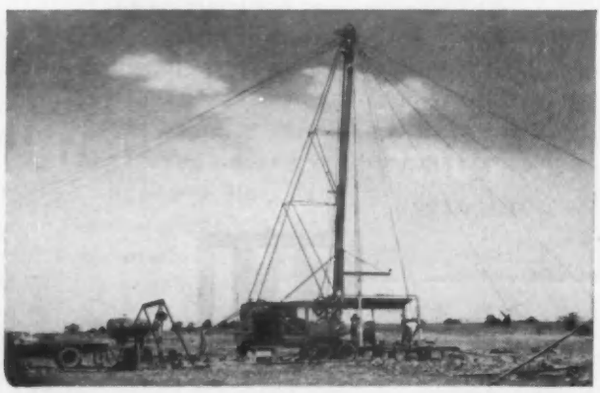
Eight large wheels, equipped with fast-acting air brakes, evenly distribute the rig's weight. Heavy-duty tires cushion the machine on the highway and off. Since the axles are free to oscillate independently of the frame, the wheels can follow uneven ground without putting undue stress on the frame.

Upon reaching the drilling location, a Bucyrus-Erie spudder is "making hole" in short order. The telescoped derrick is power raised and extended — braces fall right into place. Even the big 48-L can be rigged up and readied for work in a matter of hours instead of days.

Mobility is just one of many reasons why these machines give you faster well completions. Get full details from your Bucyrus-Erie spudder distributor — the 36-L for drilling to 3,500 feet, servicing to 4,000 feet; the 48-L for drilling to 6,000 feet, servicing to 7,000 feet. 13555







This 36-L spudder, equipped with tandem axle mounting, was drilling-in a well in Oklahoma. Estimated depth was 1,600 feet.

BUCYRUS-ERIE COMPANY
South Milwaukee, Wisconsin

BUCYRUS ERIE

*ROLOCHECK OIL WELL METERS

assure greater accuracy and less maintenance

IN MEASURING CRUDE OIL OR SALT WATER

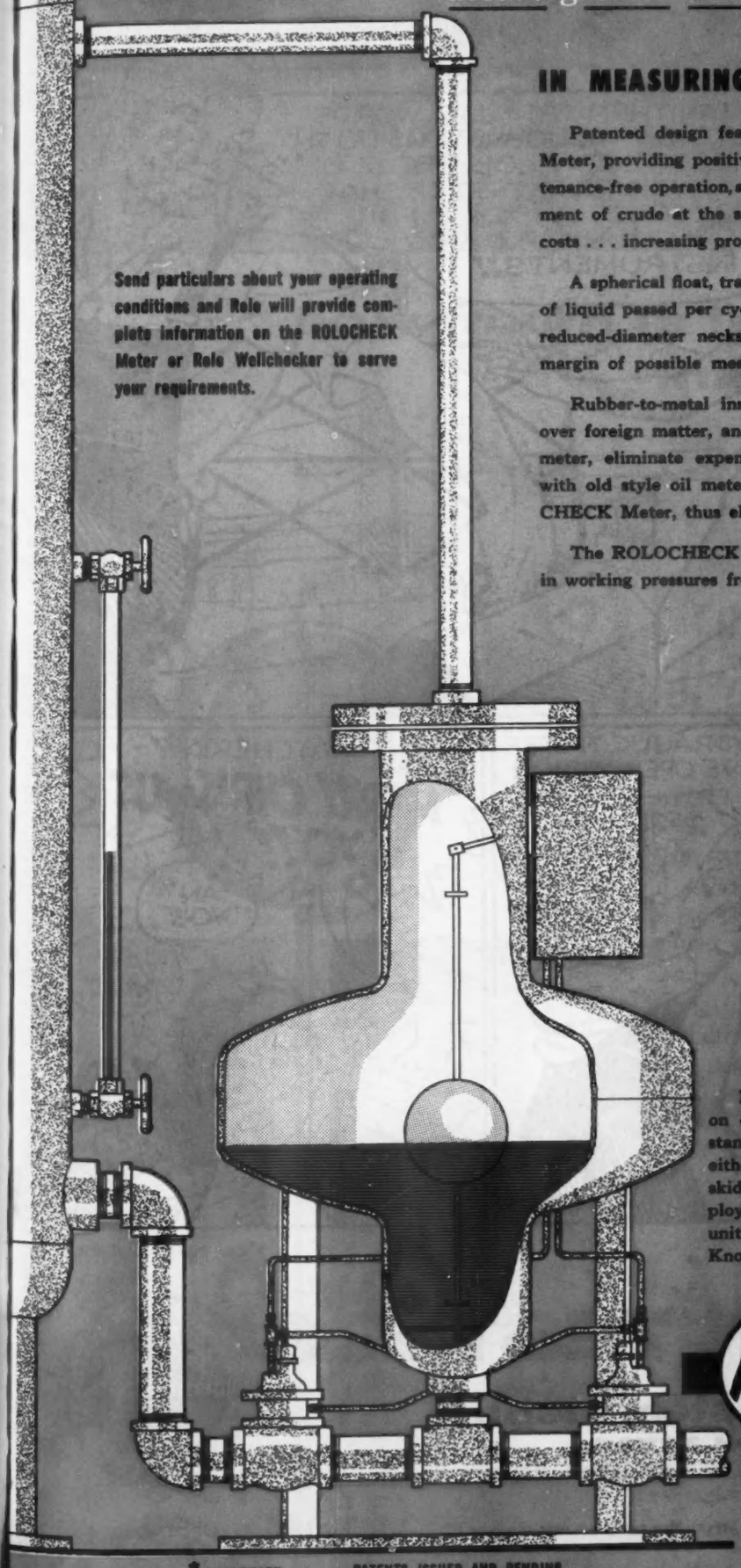
Patented design features of the simplified ROLOCHECK Oil Well Meter, providing positive dumps, positive liquid-level control and maintenance-free operation, assure greater dependability of automatic measurement of crude at the separator on the lease . . . reducing measurement costs . . . increasing profits.

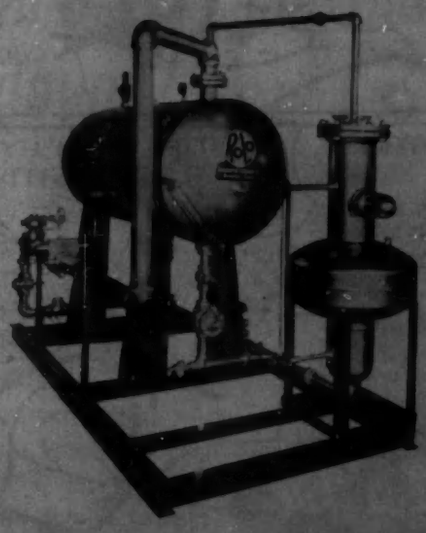
A spherical float, traveling between positive stops, controls the volume of liquid passed per cycle. The liquid level control points are located in reduced-diameter necks at the upper and lower levels, minimizing the margin of possible measurement error in each dump.

Rubber-to-metal inner valves in the dump valves, which will seat over foreign matter, and the lack of close-clearance moving parts in the meter, eliminate expensive maintenance problems usually encountered with old style oil meters. Also, free gas cannot pass through a ROLOCHECK Meter, thus eliminating another source of maintenance worries.

The ROLOCHECK Meter has a zero minimum rate, and is available in working pressures from 150 to 2000 psi and capacities to 4000 BPD.

Send particulars about your operating conditions and Rolo will provide complete information on the ROLOCHECK Meter or Rolo Wellchecker to serve your requirements.





ROLOCHECK Meters are available for installation on existing separators or treaters, and are also now standard equipment on complete Rolo Wellcheckers, either skid- or trailer-mounted. Shown above is a skid-mounted Wellchecker, Type 4-1H-3006-24, employing a ROLOCHECK Oil Meter. These compact units are also available with Automatic Free-Water Knockout.

CRUDE OIL METERING SPECIALISTS

ROLO MANUFACTURING COMPANY

P. O. Box 6783, Houston 5, Texas

BRANCHES: Corpus Christi, Midland, Kilgore, Tulsa, Lafayette, Los Angeles, Casper, Mt. Vernon, Ill., Caracas, Venezuela (PETICON).

EXPORT OFFICE: R. S. Stokvis & Sons, Inc., 17 Battery Place, New York, N. Y.

* TRADEMARK PATENTS ISSUED AND PENDING

AVAILABLE JOHNSTON by AL CAPP

STOP!!-AN' WHISPER TH' WORDS AH IS DYIN' T' HEAR!!
YO' MEAN THEM THRILLIN' WORDS 'BOUT HOW WE JOHNSTONS DO TH' FINEST TESTIN' JOB, BECUZ O' TH' HYDRAULIC TESTER, THAT PREVENTS SHOCK T' FOR-MAY-SHUN, PIPE, AN' INSTRUMENTS!!
NO!!-THOSE EVEN MORE THRILLIN' WORDS, 'BOUT--
'BOUT HOW TH' HYDRAULIC TESTER GIVES YO' POSITIVE OPER-AYSHUN EV'RY TIME?-
pSST!!-AH THINKS SHE MEANS---
OH!!-NATCHERLY!!- MERRY CHRISMUS T' YO'!!
-AN' YO'!!
-AN' YO'!!
Cal Capp

C-549

Copr. Capp Enterprises 1954

JOHNSTON TESTERS

first in drill stem testing

HOUSTON, TEXAS

LOS ANGELES, CALIF • CALGARY, CAN.

FORMATION AND CASING TESTING — JOHNSTON

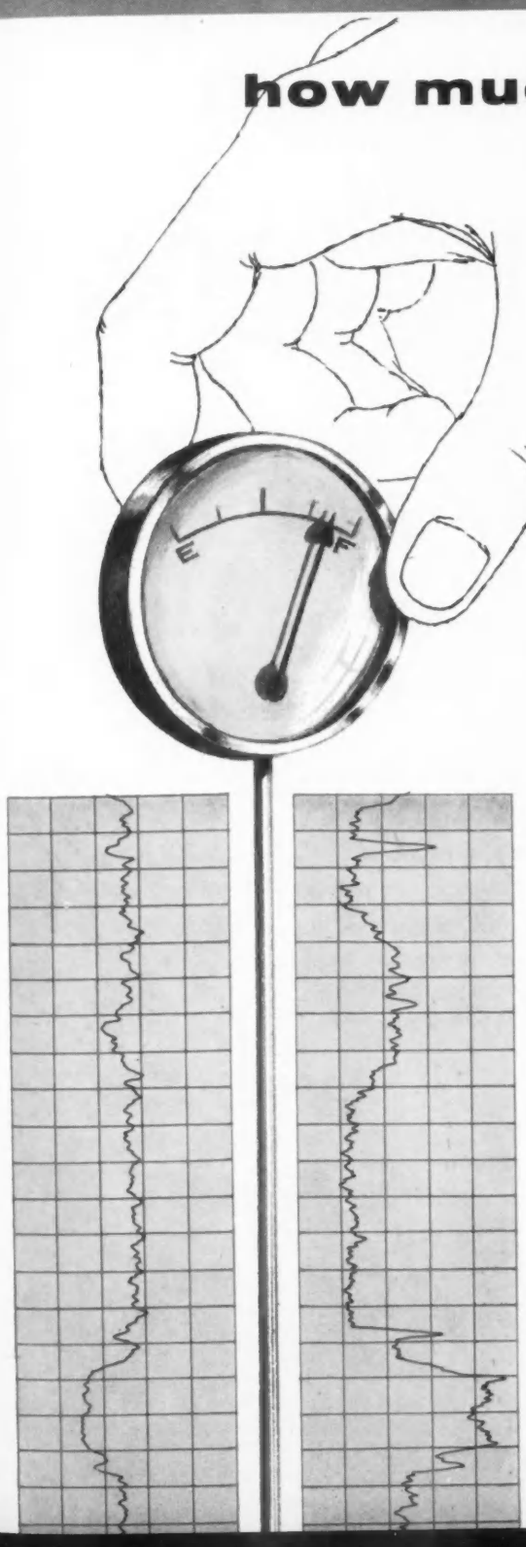
Current Outlook Section

WORLD OIL

L. J. LOGAN, SECTION EDITOR

how much is in that pay zone?

"Q.I." can often add the "fuel gauge"



"Q.I." stands for *Lane-Wells Quantitative Interpretation of Radioactivity Well Logs* – the service which adds for you the all-important information "How Much." For over three years now, operators in Texas, Kansas, Oklahoma and other states have found Q.I.'s estimates of reservoir potential sufficiently accurate for all commercial purposes. New and improved techniques, together with the steadily increasing amount of down-hole data, are rapidly extending Quantitative Interpretation to more and more fields whose formation responses permit reliable evaluation. Your Lane-Wells man can tell you all about this important service—check with him now.

Tomorrow's Tools – Today!®

LANE-WELLS COMPANY

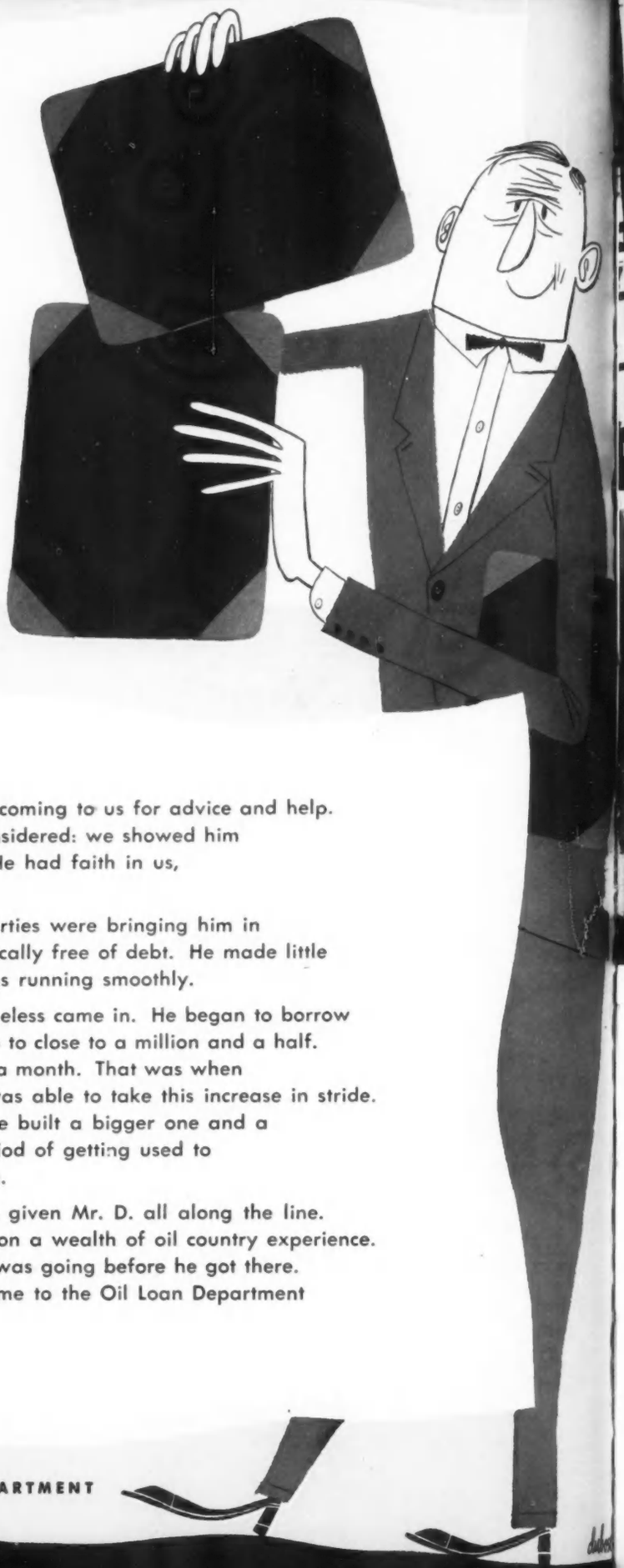
Radioactivity Well Logging

General Offices, Export Office, Plant
5610 So. Soto St., Los Angeles 58

LOS ANGELES • HOUSTON • OKLAHOMA CITY
LANE-WELLS CANADIAN CO. IN CANADA
PETRO-TECH SERVICE CO. IN VENEZUELA

LR-84-A

Mr. "D" came for advice



When Mr. D. first got started he began coming to us for advice and help. We helped him in a way that he had not considered: we showed him the need for building a good organization. He had faith in us, and he did build a good operation.

Mr. D. was doing pretty well. His properties were bringing him in around $25,000 a month, and he was practically free of debt. He made little deals all the time, just enough to keep things running smoothly.

Then a wildcat that was considered hopeless came in. He began to borrow to define his field limits, and his debt ran up to close to a million and a half. But his income jumped to around $100,000 a month. That was when Mr. D.'s organization paid off for him. He was able to take this increase in stride. With the nucleus of a strong organization, he built a bigger one and a strong one. Instead of having a difficult period of getting used to bigger operations, he sailed smoothly along.

We are proud of the help that we have given Mr. D. all along the line. We helped him with impartial advice based on a wealth of oil country experience. We helped him because we knew where he was going before he got there. This sort of help is why oil men **going up** come to the Oil Loan Department of The National Bank of Commerce.

E. O. BUCK, VICE PRESIDENT, OIL LOAN DEPARTMENT

THE NATIONAL BANK OF COMMERCE
OF HOUSTON

Gulf Building, Houston, Texas "The Bank for All the People"

MEMBER FEDERAL DEPOSIT INSURANCE CORPORATION

Shop for more profit at this "GENERAL STORE"

There are two sure ways to save time and money in the field: (1) anticipate the need for supplies before it occurs, and (2) meet that need by getting quality supply items from a single, reliable source. You can do both by stopping at a National Supply Store.

Here, the "general store" atmosphere of friendly, helpful service is combined with selected quality stocks to meet your needs. Take the time to look over these items of quality equipment, operating supplies, hand tools and accessories. The shopping you do in the display areas, shelves and bins will pay dividends in more profitable operations, now and later. If you need an unusual item not in stock, the store personnel will be glad to get it for you.

It pays to ask about new product developments, too. National Supply men will give you the information, as well as outstanding supply service, on new products that can make your operations more profitable.

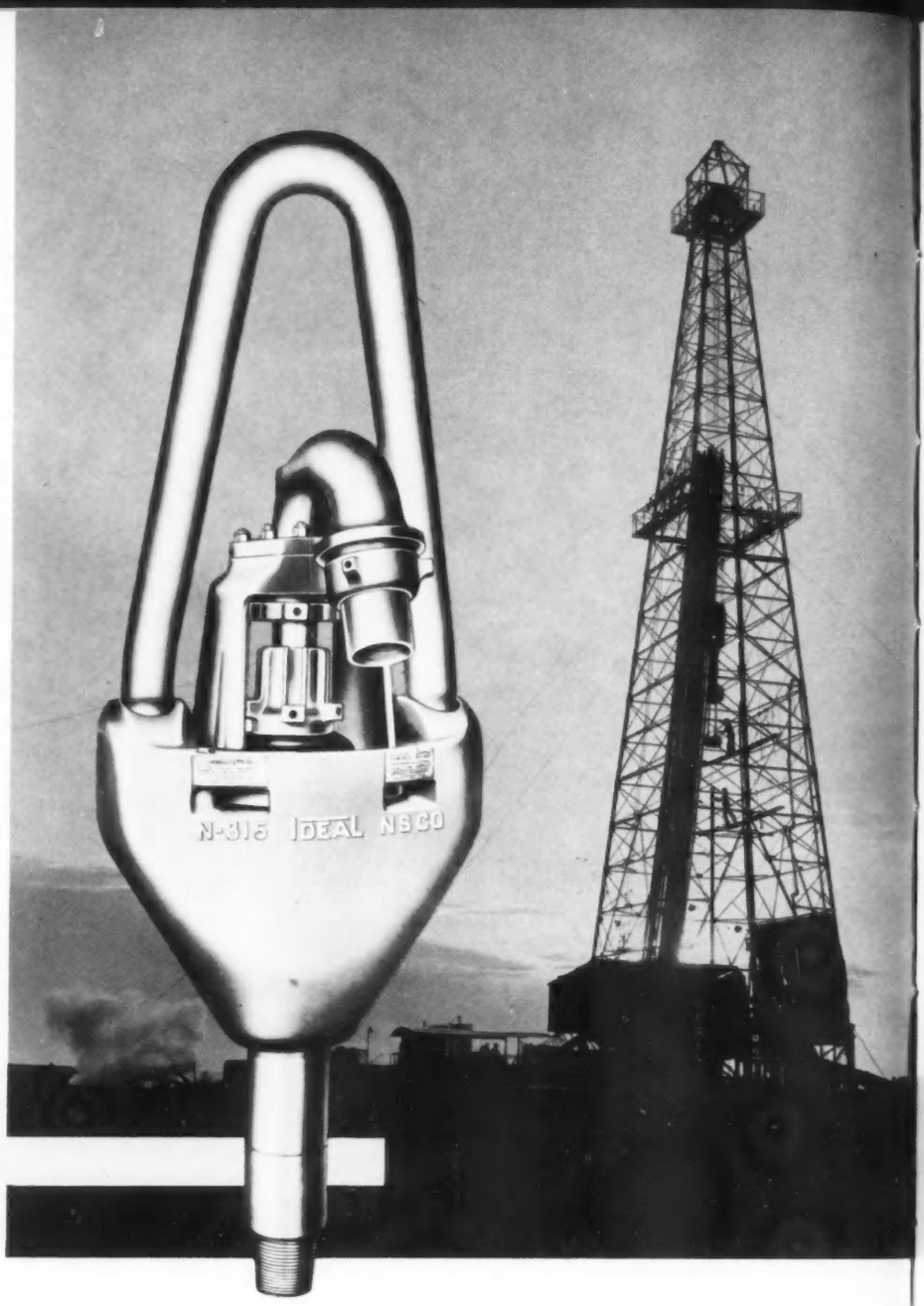
Traditionally and now, a complete line of quality equipment and helpful service have made National Supply the leading "storekeeper to the oil industry." Thousands of satisfied customers who shop for more profit in our 124 stores confirm this reputation.

THE
NATIONAL SUPPLY
COMPANY

Why it costs less to use an

IDEAL®

"TYPE N" SWIVEL:



The simple, compact design of Type N Swivels is characteristic of the built-in safety of products bearing the Ideal trademark. However, this feature is just one of several that insure continuous service at low operating and maintenance costs. Take a close look at these additional reasons why an Ideal Swivel cuts the cost of drilling:

Reduced weight: Complete redesigning has been employed to bring every model of Ideal Swivels down to minimum weight in relation to individual rated capacity. The use of high quality, high-strength components throughout every swivel has reduced both over-all height and weight to greatly facilitate handling.

Lower center of gravity: Centerline of the bail pins on the Type N Ideal Swivels has been raised, thereby lowering center of gravity. This means greater stability in handling, makes connection of swivel "sub" to kelly easier and faster.

Streamlined exterior: The one-piece steel body of the Ideal Type N Swivel is free from any dangerous projections. All bolts, nuts, pins and grease fittings are recessed to assure maximum safety to the derrick crew.

Fast wash pipe replacement: National's exclusive Uniflex Wash Pipe Box assembly is standard on all Type N Swivels. An approved method for packing off the mud, the Uniflex assembly also features quick-acting threads to speed replacement . . . is easily assembled by one man, and can be installed without removing gooseneck or hose connection.

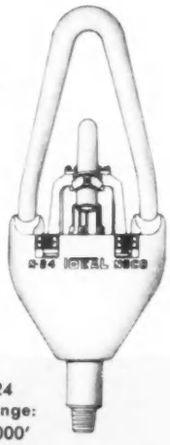
Rapid hose coupling: Also standard in these swivels is the Quick-Seal Hose Connection that speeds make-up of hose joint. Besides eliminating one hose connection member and minimizing mud leakage, the Ideal Quick-Seal Connection features larger, quick-acting threads and sealing elements to withstand rugged use.

For complete details on Ideal Type N Swivels, see your National Supply representative soon. He'll be glad to help you select the one which meets your needs best.

There's an IDEAL® "Type N" Swivel for every job—

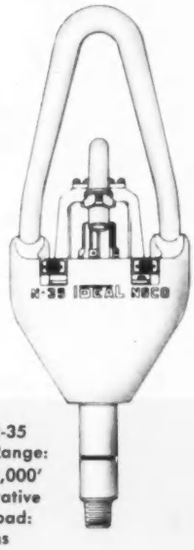
which one can you best use
to reduce your drilling costs?

N-24



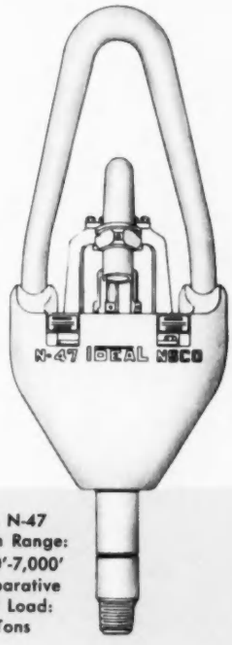
Ideal N-24
Depth Range:
2,000'-4,000'
Comparative
Dead Load:
110 Tons

N-35



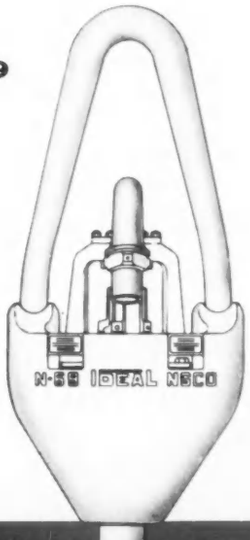
Ideal N-35
Depth Range:
3,000'-5,000'
Comparative
Dead Load:
150 Tons

N-47



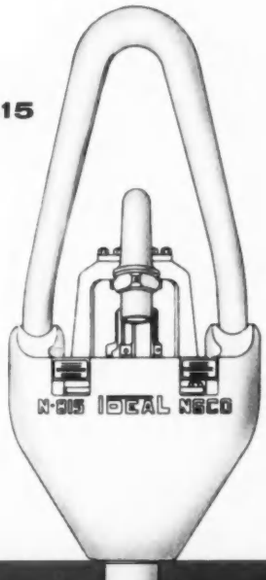
Ideal N-47
Depth Range:
4'000'-7,000'
Comparative
Dead Load:
200 Tons

N-69



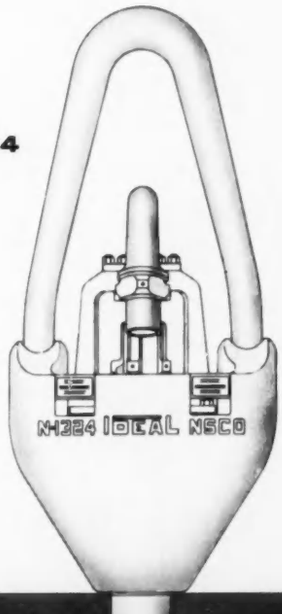
Ideal N-69
Depth Range:
6,000'-9,000'
Comparative
Dead Load:
300 Tons

N-815



Ideal N-815
Depth Range:
8,000'-15,000'
Comparative
Dead Load:
400 Tons

N-1324



Ideal N-1324
Depth Range:
13,000'-24,000'
Comparative
Dead Load:
500 Tons

Looking for a dependable block, too? See the next page...

THE
NATIONAL SUPPLY
COMPANY

MAIN OFFICE: Two Gateway Center, Pittsburgh 22, Penna.
DIVISION OFFICES: Denver; Ft. Worth; Houston; Toledo; Tulsa; Torrance
CANADA: The National Supply Company, Ltd., 200 F. W. Clark Building, 709 Eighth Avenue, West, Calgary, Alberta
EXPORT: 600 Fifth Avenue, New York 20, N. Y., U. S. A.; City Wall House, Chiswell Street, London E. C. 1

NATIONAL BLUE OIL FIELD MACHINERY AND EQUIPMENT
SPANG STEEL PIPE AND ELECTRICAL CONDUIT

You get fast, true running action with

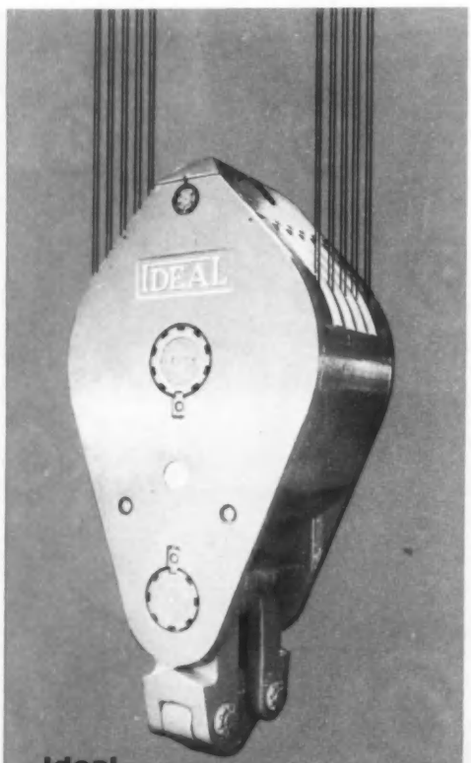
SAFETY-ENGINEERED IDEAL® BLOCKS

If you're losing time and money because of slow or unsafe block action, Ideal Hook Blocks or Traveling Blocks can solve your problems. Every Ideal Block is engineered for safety, built for rugged service and thoroughly field-tested. You can choose from a complete line of Hook Blocks and Traveling Blocks that National has developed for every drilling need, and get the outstanding features shown below:

Ideal Type E

HOOK BLOCK

Designed to effect the greatest possible saving in vertical derrick space, this 200-ton rated block is typical of the Type E line. Ideal Type E Blocks are available in three sizes for 90- to 200-ton loads.



Ideal Type F

TRAVELING BLOCK

Typical of National's Type F series blocks, this 300-ton capacity traveling block is designed to remain stable in operation even under no load. Ideal Type F Blocks are available in two sizes for 300- to 450-ton loads.

Ideal Type F

UNIVERSAL HOOK BLOCK

The new swivel block "universal" pin joint feature in this heavy-duty, 300-ton rated block distinguishes it from rigidly connected hook and block combinations. Ideal Type F Universal Blocks are rated for 300- to 450-ton loads.

Special hook features

- Hook body mounted on tapered roller bearings
- Elevator link supports equipped with positive retaining links
- Automatic-latching hook tongue cannot be accidentally opened
- Spring-actuated 8-position rotation lock
- Grooved hook body facilitates elevator alignment with drill pipe

Traveling block features

- Sheaves independently mounted on tapered roller bearings
- Individual lubrication to each sheave bearing
- All parts securely locked for safety
- Streamlined—all nuts, bolts, pins and fittings recessed
- Short, low stressed pins and shafts

Your National representative will be glad to give you more information about Ideal Hook Blocks, Traveling Blocks and companion Crown Blocks. Ask him soon about the units that can put new speed and safety into your drilling program.

THE NATIONAL SUPPLY COMPANY

MAIN OFFICE: Two Gateway Center, Pittsburgh 22, Penna.
DIVISION OFFICES: Denver; Ft. Worth; Houston; Toledo; Tulsa; Torrance
CANADA: The National Supply Company, Ltd., 200 F. W. Clark Building, 709 Eighth Avenue, West, Calgary, Alberta
EXPORT: 600 Fifth Avenue, New York 20, N. Y., U. S. A.; City Wall House, Chiswell Street, London E. C. 1

NATIONAL BLUE OIL FIELD MACHINERY AND EQUIPMENT
SPANG STEEL PIPE AND ELECTRICAL CONDUIT

HR

(The High Resolution Reflection System)

. . . casts a deeper shadow than we thought!

1930 ☆ 1955 GSI 25TH ANNIVERSARY ®

A year ago HR was a new seismic tool . . . the system's filters, extremely rapid AGC rate and its fast paper drive were especially designed for recording high frequency energy. We were cautious. We set the effectiveness of HR at a depth range of from 100 to 2500 feet.

Now, GSI experience has proved that HR not only operates effectively within that range, but can also supply *the resolving power needed for solving structural and stratigraphic problems at depths of 5000 feet and greater.*

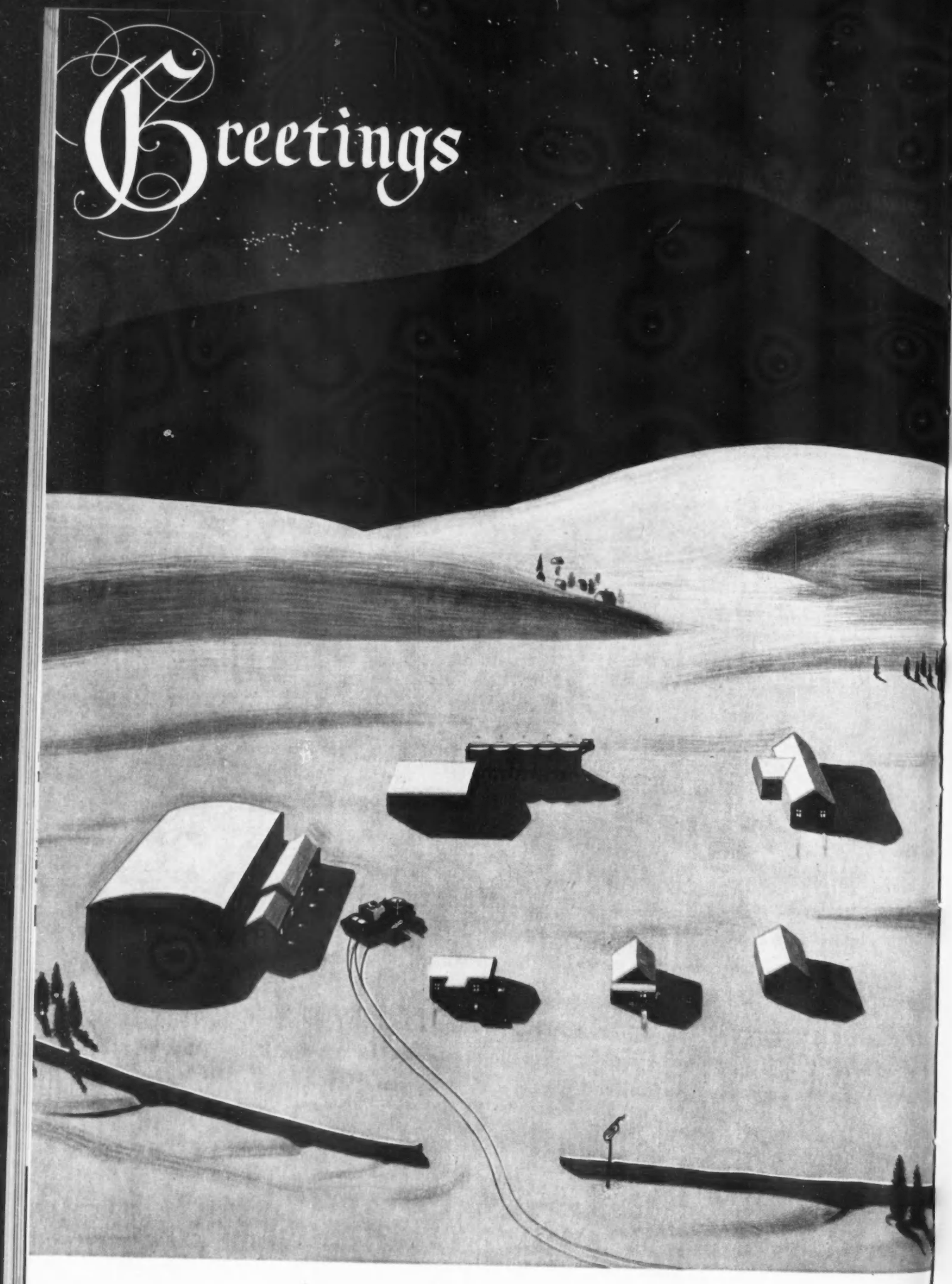
GSI experience with HR in Oklahoma, Kansas, Colorado, California, Canada and Texas has proved that HR greatly exceeds our hopes. In some areas, HR has produced reliable results from 6000 to 8000 feet.

Contact GSI . . . the geophysical contractor best qualified in applying this new tool to oil finding. We shall be happy to have a representative call and discuss HR with you.

Write for Bulletin 55-3 on application of the HR System.

GEOPHYSICAL SERVICE INC.
5900 LEMMON AVENUE • DALLAS 9, TEXAS

Finding a World of Oil for a Quarter-Century


Greetings
★ ★ ★ from HALLIBURTON

We send you best wishes
for a Happy Holiday Season
from our Houston Headquarters.

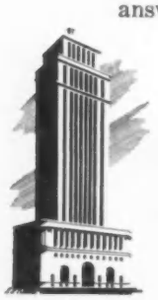
SCHLUMBERGER
Well Surveying Corporation
THE EYES OF THE OIL INDUSTRY

When timing is important call on Canada's Oil Bank

Because of its capacity to meet the exacting requirements of the industry for prompt action and accurate information, The Royal Bank of Canada has been long and widely known as "Canada's Oil Bank".

The "Royal's" Oil and Gas Department in Calgary is staffed by men who specialize in all phases of oil and gas financing. They can answer your questions quickly and with authority. Its branches, serving all major producing areas, and many new districts of rich promise, provide complete banking service and a wealth of information at the local level. There are over 280 Branches of this bank in British Columbia, Alberta, Saskatchewan and Manitoba alone. Your enquiries are invited.

We do not supply information on oil securities.



THE ROYAL BANK OF CANADA

Canada's Largest Bank

New York Agency—68 William Street, New York 5, N. Y.

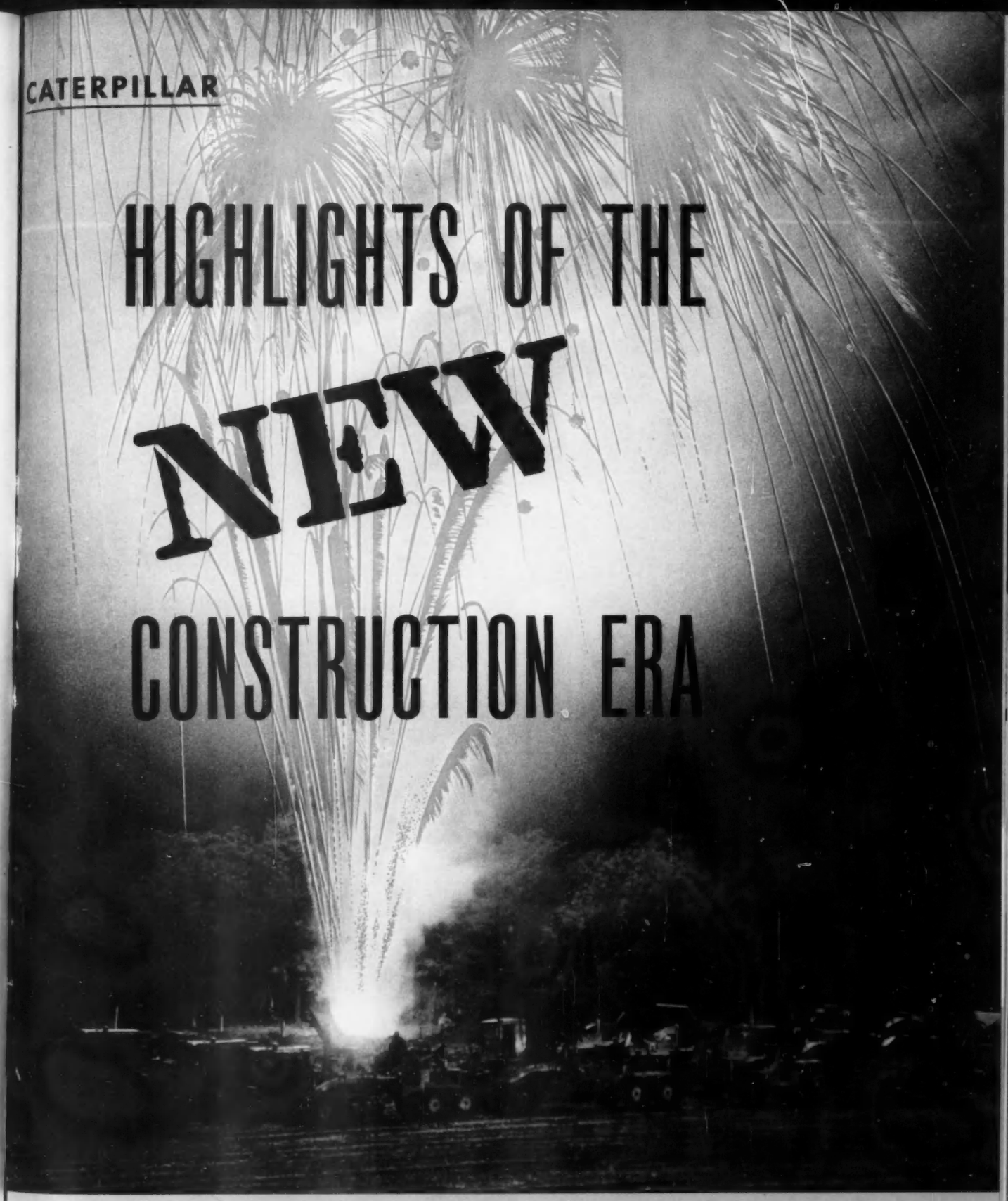
Total assets exceed $3,000,000,000

Over 800 branches in Canada, the West Indies, Central and South America, New York, London and Paris.

For a free booklet describing our Special Bulletin Service, and containing other interesting information about Canada's fast-growing oil and gas industry, write to our Oil & Gas Department, Calgary, Alta.

CATERPILLAR

HIGHLIGHTS OF THE NEW CONSTRUCTION ERA



Never before in history has the equipment industry faced such a tremendous challenge as today. We are entering what might well be called the "construction era." Right now construction is the greatest single factor in our industrial economy, employing 12% of our total labor force. And construction can never move forward by itself. Its progress is dependent upon increased production in mines and forests, cement mills and steel plants. Caterpillar Tractor Co. is matching these new opportunities with an array of new products that will increase production, cut maintenance costs, work longer and more profitably than any other equipment on the market. These Caterpillar-built products are the result of continuing research in the laboratory and in the field. They are forceful evidence of Caterpillar Leadership in Action. See them on the following pages.

NEW in track-type tractors!

The new D9

This new giant is a bear for work. Choice of torque converter or exclusive oil clutch drive. First track-type tractor with Turbocharger. Completely new 286 HP engine. "Live-shaft" drive for rear-mounted equipment. Many other important features.

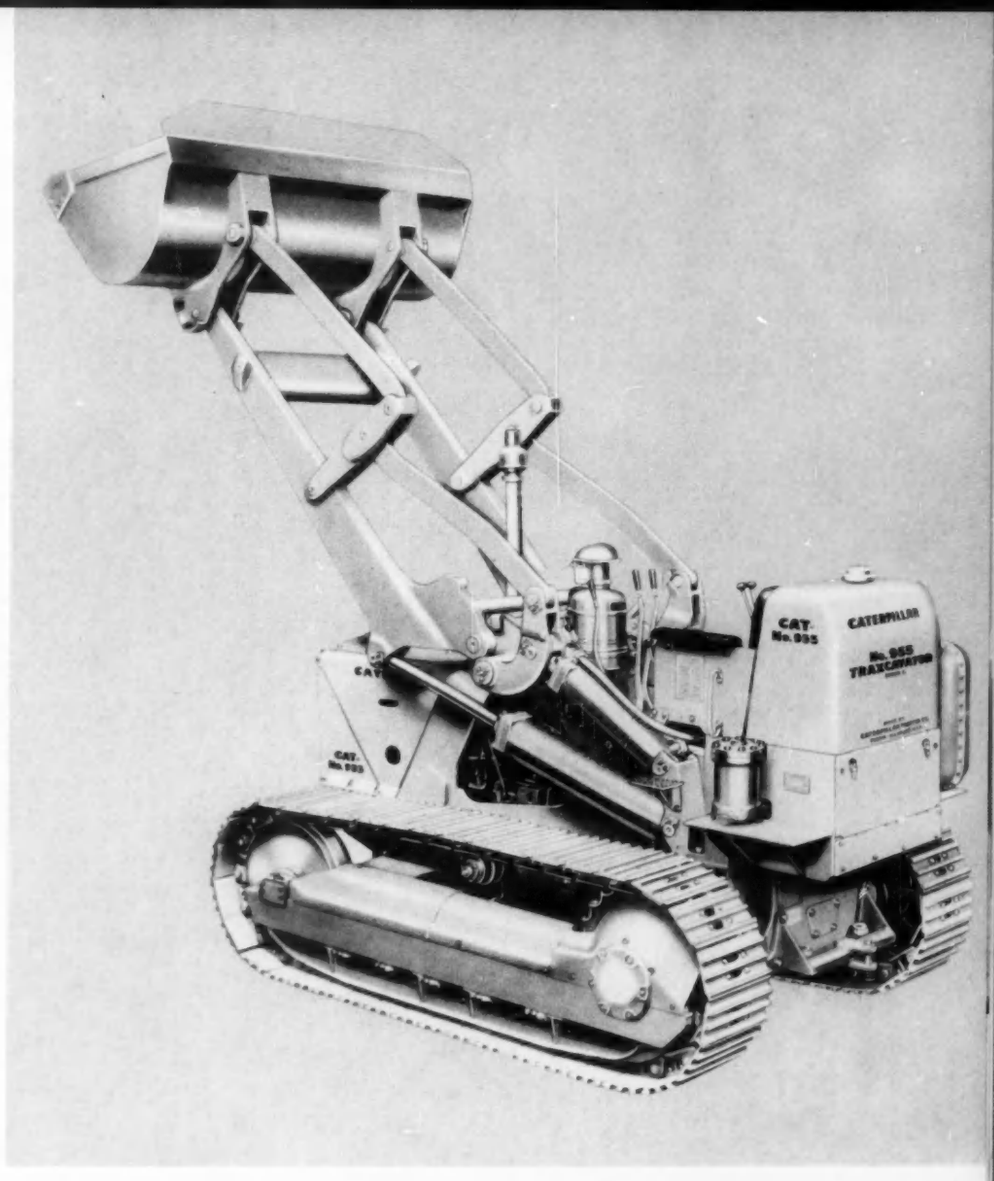
The new D8

With torque converter (Series D) or direct drive (Series E). Completely new 191 HP engine. "Live-shaft" drive for rear-mounted equipment independent of flywheel clutch. New easy controls. Many other improvements. Shown with new Cat No. 463 LOWBOWL Scraper.

The new D7 (Series C)

New 128 HP engine. Drawbar pull 28,700 lb. maximum. Exclusive oil clutch. Finger-tip steering. New starting engine for easier operation. Track shoes hardened by "*water quench*" process (also on D8 and D9). Many other important advances.

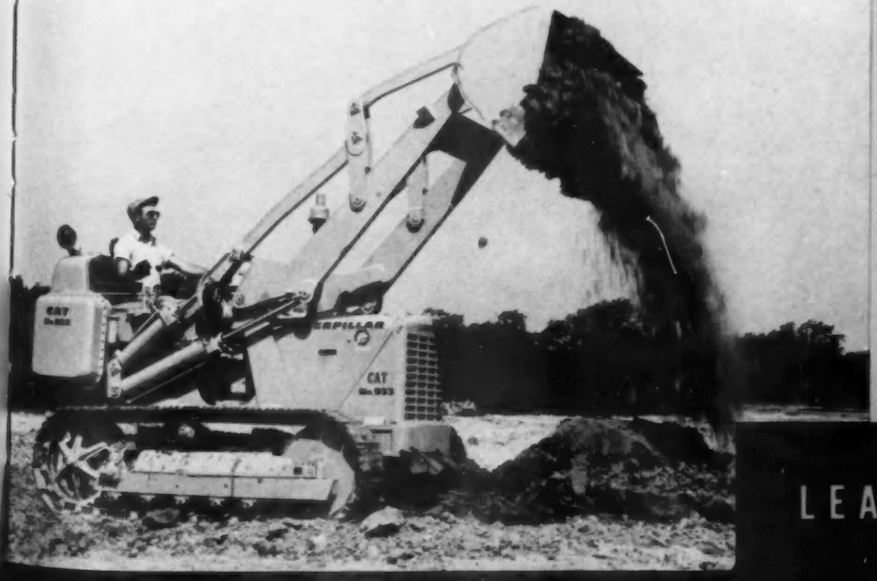
LEADERSHIP IN ACTION



No. 955 – 1½-yard capacity

Balanced for bigger production at lower cost. Major features: 40-degree bucket tip-back at ground level, new oil-type clutch, convenient lift and dump levers, modern hydraulic system, high reach, "designed in" operator comfort, optional starting and versatile attachments.

NEW in Traxcavators!



No. 933 – 1-yard capacity

Like its bigger brother, *balanced* to outproduce ordinary tractor-shovels of equivalent capacity. Also backed by *one* manufacturer to provide you the advantages of single manufacturing responsibility and one service source. Major features—same as the No. 955!

LEADERSHIP IN ACTION

NEW in wheel-type tractors!

The new DW21 Tractor ▲

(Series C.) New 300 HP Caterpillar Engine with Turbocharger. 10% more rimpull. New No. 470 LOWBOWL Scraper. 18 cubic yards struck, 25 cubic yards heaped capacity. New, wide-section 29.5-29 tires give big-footprint flotation and maximum traction. Many other new, thoroughly tested features.

The new DW15 Tractor ▶

(Series C.) 186 HP valve-in-head Caterpillar Engine. Speeds up to 24 MPH (31.3 MPH with optional gears) pulling loaded wagon or scraper. Heavy-duty clutch has air booster. Air brakes. Wide range of speeds: 10 forward, 2 reverse.

The new DW20 Tractor

(Series E.) Shown with new No. 456 LOWBOWL Scraper. This great new team highballs up to 32.1 MPH for fast cycle times. Same 300 HP engine with Turbocharger and wide-section tires as DW21. LOWBOWL design loads more material in less time by using tractor and pusher power at maximum efficiency.

LEADERSHIP IN ACTION

NEW in pipelayers!

The new No. 583

Here, for the first time, is a pipelayer that is *all* pipelayer—not a tractor attachment. It's the most efficient, highest capacity pipelayer in history. Lifting capacity of 130,000 pounds and 21-inch clearance. Three-stage torque converter in main drive and new hydraulically actuated counterweights. Stability is unequalled. A heavy-duty constant-mesh pipelayer winch transmission drives directly from the engine. Many more important advances, all designed to produce more profits for pipeliners.

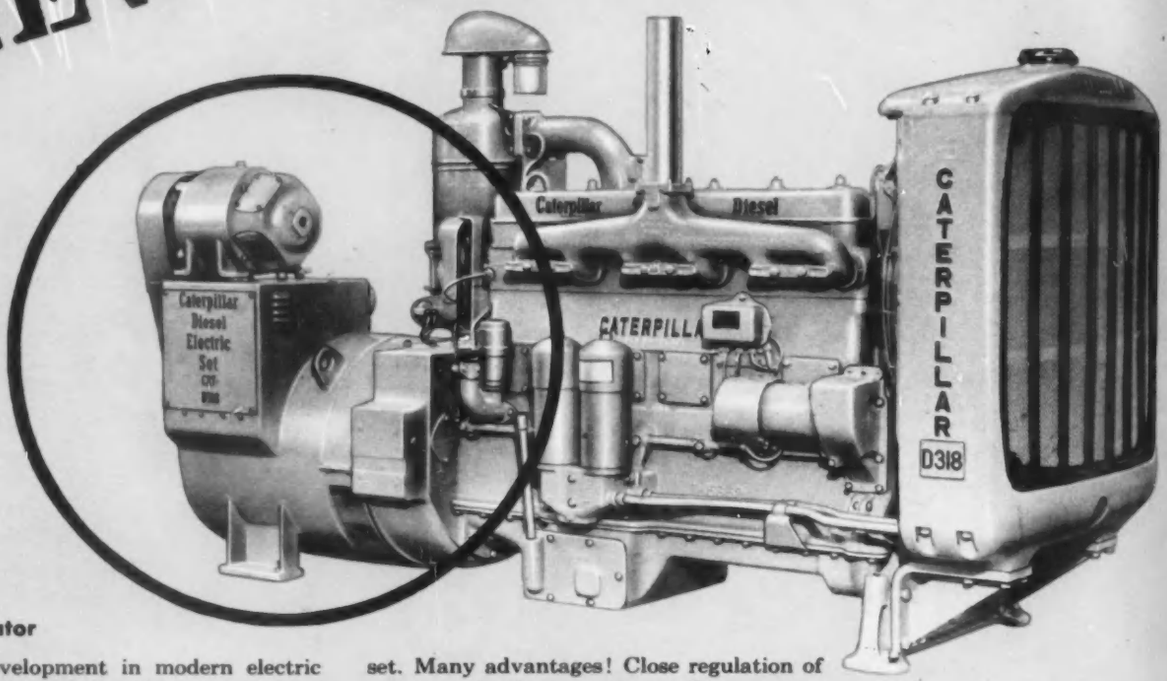
NEW in motor graders!

The new No. 12 with oil clutch

With the addition of the job-proven oil clutch, the big, versatile No. 12 Motor Grader gives you more economy and efficiency than ever. The new clutch increases work life since the constant oil bath lubrication reduces wear on all moving parts. There is less maintenance; 1500 hours without adjustment is not unusual and no external lubrication is needed. The new No. 12 is more efficient because the clutch is constantly cooled, eliminating clutch fade and slippage due to overheating.

LEADERSHIP IN ACTION

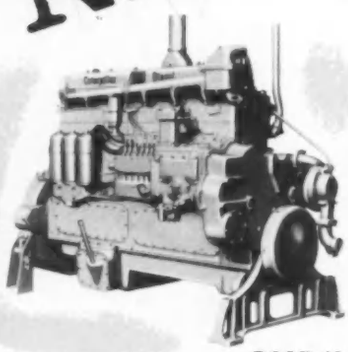
NEW in generators!



Cat Generator

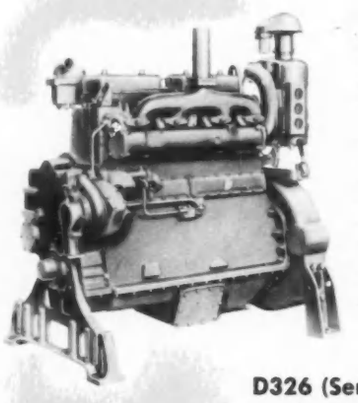
A major development in modern electric power. Brings to Caterpillar's new line of Diesel Electric Sets the efficiency of the externally-regulated set in a self-regulated set. Many advantages! Close regulation of voltage, simple control, excellent motor-starting ability, easy hook-up with other generators . . . 100% backed by Caterpillar.

NEW in diesel engines!



D342—210 HP maximum @ 1200 RPM

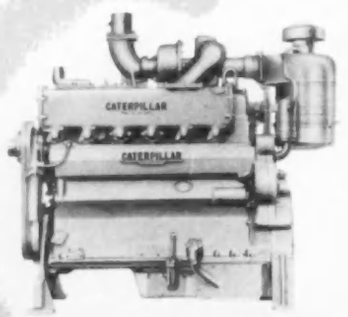
Incorporates the latest advances in modern, compact, heavy-duty diesel design. Offers better operation, less maintenance, higher horsepower. Choice of 3 starting systems—air, electric, gasoline. Like all Caterpillar Engines, burns wide range of fuels without fouling.



D339—140 HP maximum @ 1200 RPM

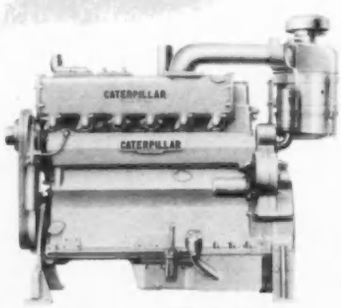
Combines new compactness with greater efficiency, economy and higher horsepower. A modern, heavy-duty 4-cylinder unit with new smoothness of operation. Choice of 3 starting systems. Many other advantages, including full-flow filtering system.

D337 (Series F) with Turbocharger 310 HP maximum @ 2000 RPM



New Turbocharger utilizes exhaust heat to drive supercharger, delivers air in proportion to engine's need. New hydraulic valve lifters practically eliminate adjustment, provide quiet operation. Greater displacement for more power. Choice of 3 starting systems. Available as Electric Sets and Industrial Engines with complete line of attachments.

D326 (Series F)—200 HP maximum @ 2000 RPM

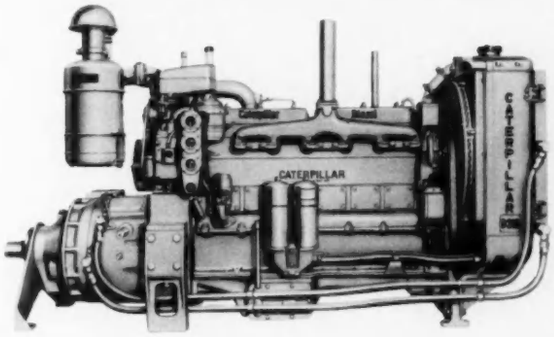


Like other new, heavy-duty Cat Diesels, offers you more for your money than any engine in its power range. Many major features, including hydraulic valve lifters and full-flow filtering. Greater displacement for more power. Choice of 3 starting systems. Available as Electric Sets and Industrial Engines with complete line of attachments.

LEADERSHIP IN ACTION

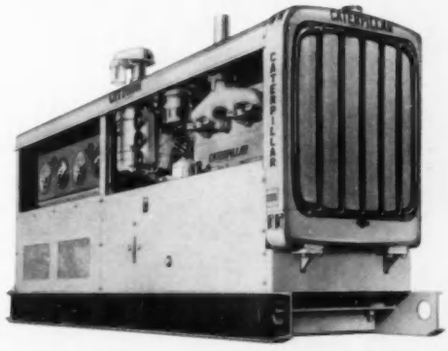
NEW in torque converters!

Caterpillar now offers a wide choice of torque converter power units in standard packages. Torque output is automatically matched to load for smooth load starts or control of load without use of clutch. Overloads can't kill engine. Your Caterpillar Dealer can supply these units. He also has full facilities and parts for service.



NEW in welders!

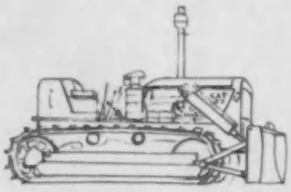
The new Caterpillar Twin Arc-Welder provides one engine, one base, and TWO 300-ampere welding generators. Four-cycle Cat Diesel picks up load instantly without missing or injector trouble. Compact design cuts transport and maintenance cost. Operators can weld at different voltages at same time. Single (3 KW) exciter cuts weight and size, provides ample excitation plus plenty of 115-V. DC for auxiliary tools.



NEW in portable electric sets!

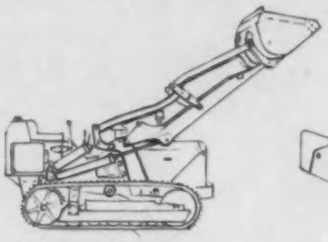
Cat Portable Electric Sets are now available in nine models, 30 to 315 KW, and in all usual voltages, 50 to 60 cycle. They're complete units with cooling system, fuel tank and switchgear, mounted on skids, semi-trailer or full trailer. Easy to hook up and operate, ready to work anywhere.

LEADERSHIP IN ACTION

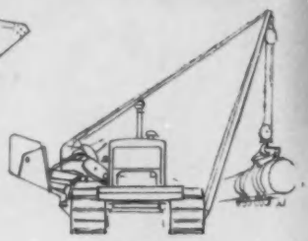


TRACK-TYPE TRACTORS

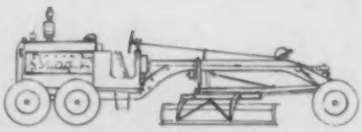
WHEEL-TYPE TRACTORS



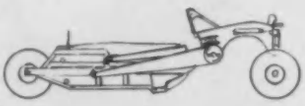
TRAXCAVATORS



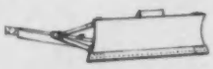
PIPELAYERS



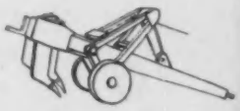
MOTOR GRADERS



SCRAPERS

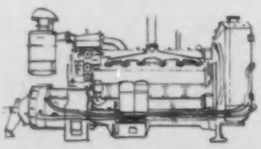


BULLDOZERS

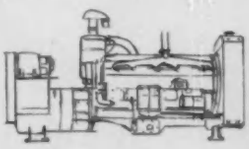


RIPPERS

INDUSTRIAL ENGINES

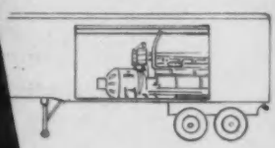


TORQUE CONVERTERS

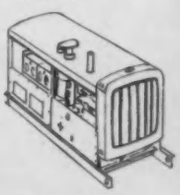


GENERATORS

FOR YOU CATERPILLAR LEADERSHIP PROVIDES THE MOST COMPLETE LINE IN THE INDUSTRY



PORTABLE ELECTRIC SETS



WELDERS

Year after year you have seen the results of Caterpillar leadership. It is always in action. It never stands still. The full resources of Caterpillar research, both in the laboratory and right in the field with you, are constantly devoted to improving products and developing new ones. This means that Caterpillar is your partner in progress, bringing you better and better products, greater opportunities for profitable work. Caterpillar Tractor Co., Peoria, Illinois, U. S. A.

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LEADERSHIP IN ACTION

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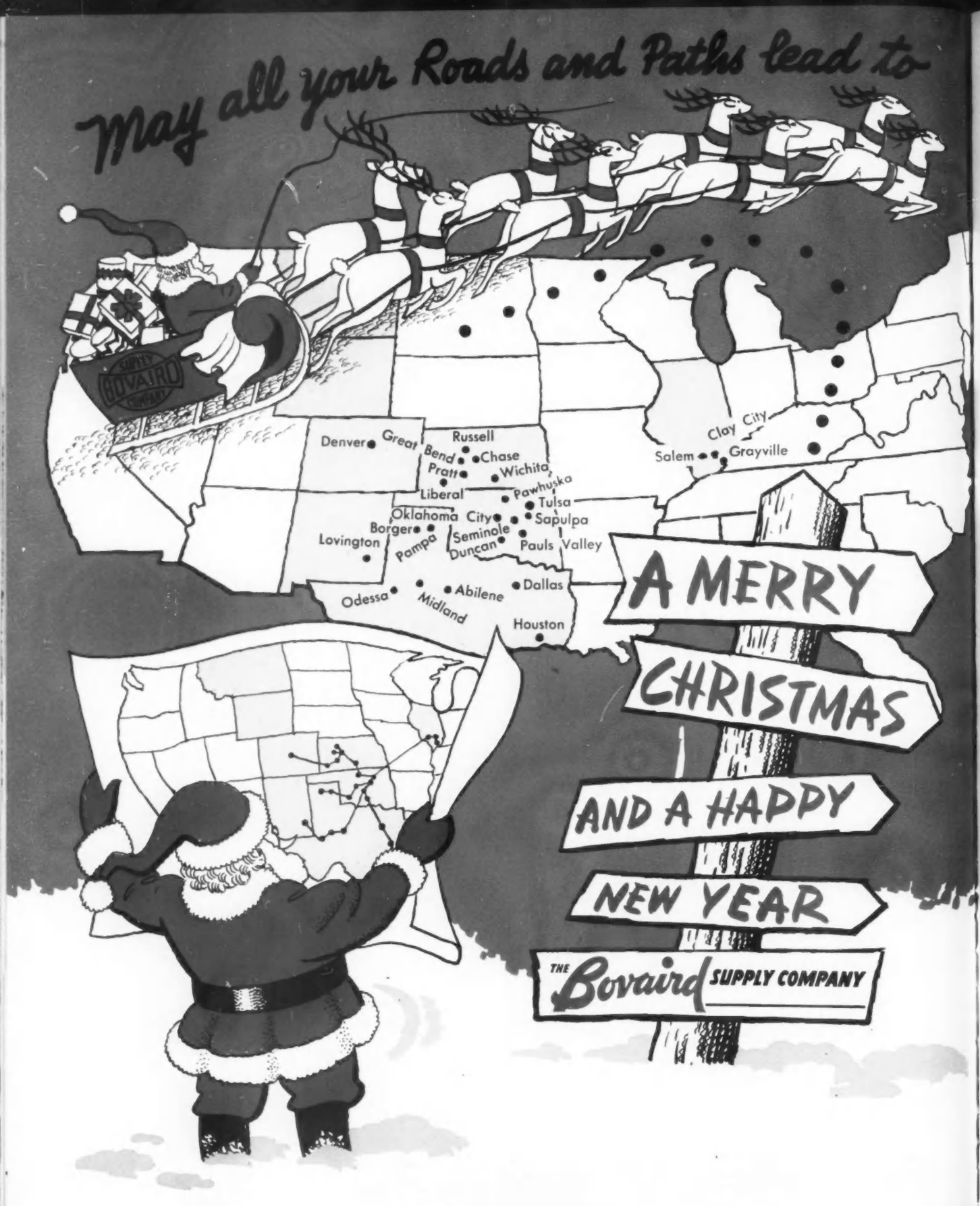
HOUSTON, TEXAS



THE Bovaird SUPPLY COMPANY

GENERAL OFFICES
TULSA, OKLAHOMA

84 YEARS OF PROGRESS WITH THE OIL INDUSTRY

Sargent RODLESS PUMP pays off 25 to 1

"Before using Sargent, 19 hydraulic pumps averaged only 17 days each in this well. The Sargent Rodless Pump is still working efficiently after 426 days"

Such a margin may seem fantastic, but it's true. Actual well records show that 19 other hydraulic pumps averaged only 17 consecutive days each before having to be pulled and serviced. A Sargent Rodless Hydraulic Pump in the same well has continued uninterrupted operation at top pumping efficiency for 426 consecutive days *and is still operating*. That's the type of impressive performance that places the Sargent Rodless Pump in a class by itself. These same records show that this particular pump and hydraulic unit had an efficiency of 98% at the hydraulic engine and 92% at the pump. This unit has proved the best method of pumping oil and performs equally effectively in any type of well. This is not an exceptional case. In field after field, under widely varied well conditions, records prove Sargent lifts more oil at lower cost per barrel. Regardless of your pumping requirements, it will pay you to check the features and advantages that enable the Sargent Rodless Pump to get you more oil at lower cost. *Write today for complete details.*

CHECK THESE FEATURES:

The Sargent Rodless Hydraulic Pump places the long-stroke unit at the bottom of the well, where it is operated hydraulically without the need for sucker rods. Rod problems and tubing wear are thus entirely eliminated. Energized by crude oil under pressure (furnished by any suitable prime mover located at the surface), the pump requires minimum operating pressure for a given pumping depth and production capacity. Plunger bumping up and down is eliminated because the unit cannot overstroke or understroke. Pump valves are accurately spaced during assembly in the shop. The close spacing and long pump strokes yield the ultimate in gas compression ratio, thus reducing gas lock difficulties.

The pump unit can be surfaced merely by turning a valve and generally can be serviced right at the well. More than twenty Sargent Field Stores furnish standard Sargent API parts and pump service in the field.

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Standard of Excellence *Since 1920*

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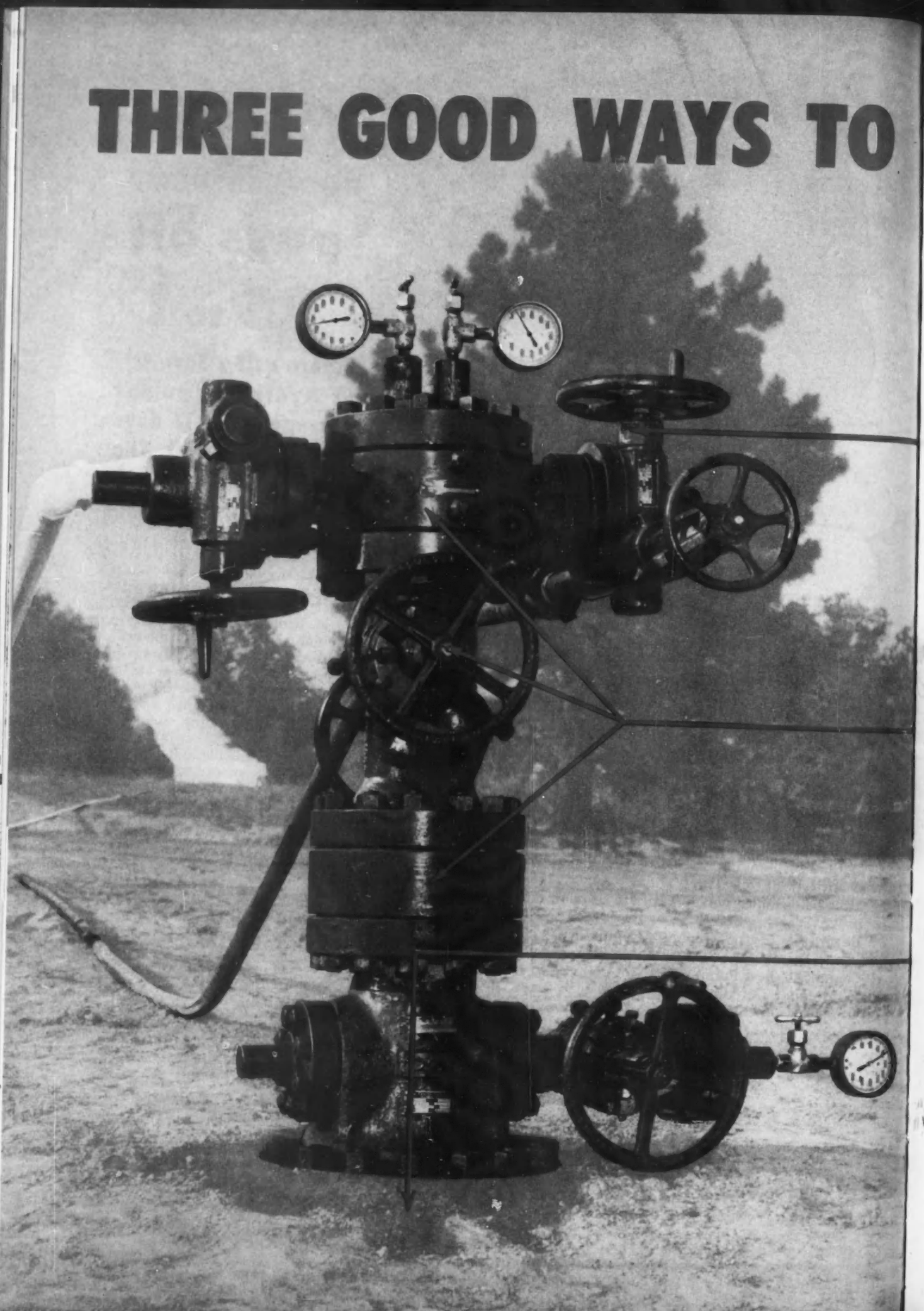
"Good will" is the disposition of the pleased customer to return to the place where he has been well treated.
—U.S. Supreme Court

BUILDS PUMPS THAT BUILD GOOD WILL

THREE GOOD WAYS TO



EVERY FIELD

OF ENDEAVOR

HAS PRODUCED

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TOP PERFORMER

The greatest

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"Red" Grange

EVERY FIELD OF ENDEAVOR

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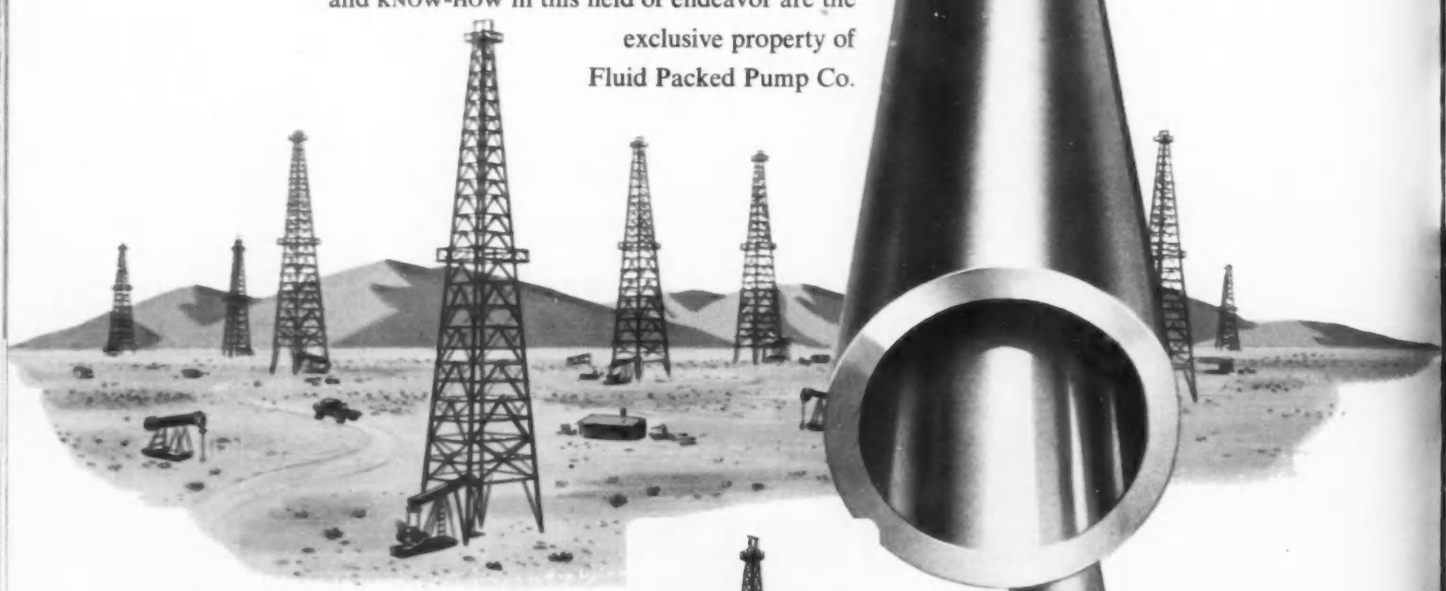
In football it was "Red" Grange—
For smooth, free plunger operation
under all kinds of pumping conditions it is

oilmaster

HARDENED AND HONED ONE PIECE PUMP BARRELS

Their design and general construction can, has and will be copied, but thirty years of EXPERIENCE and KNOW-HOW in this field of endeavor are the exclusive property of Fluid Packed Pump Co.



FLUID PACKED PUMP COMPANY
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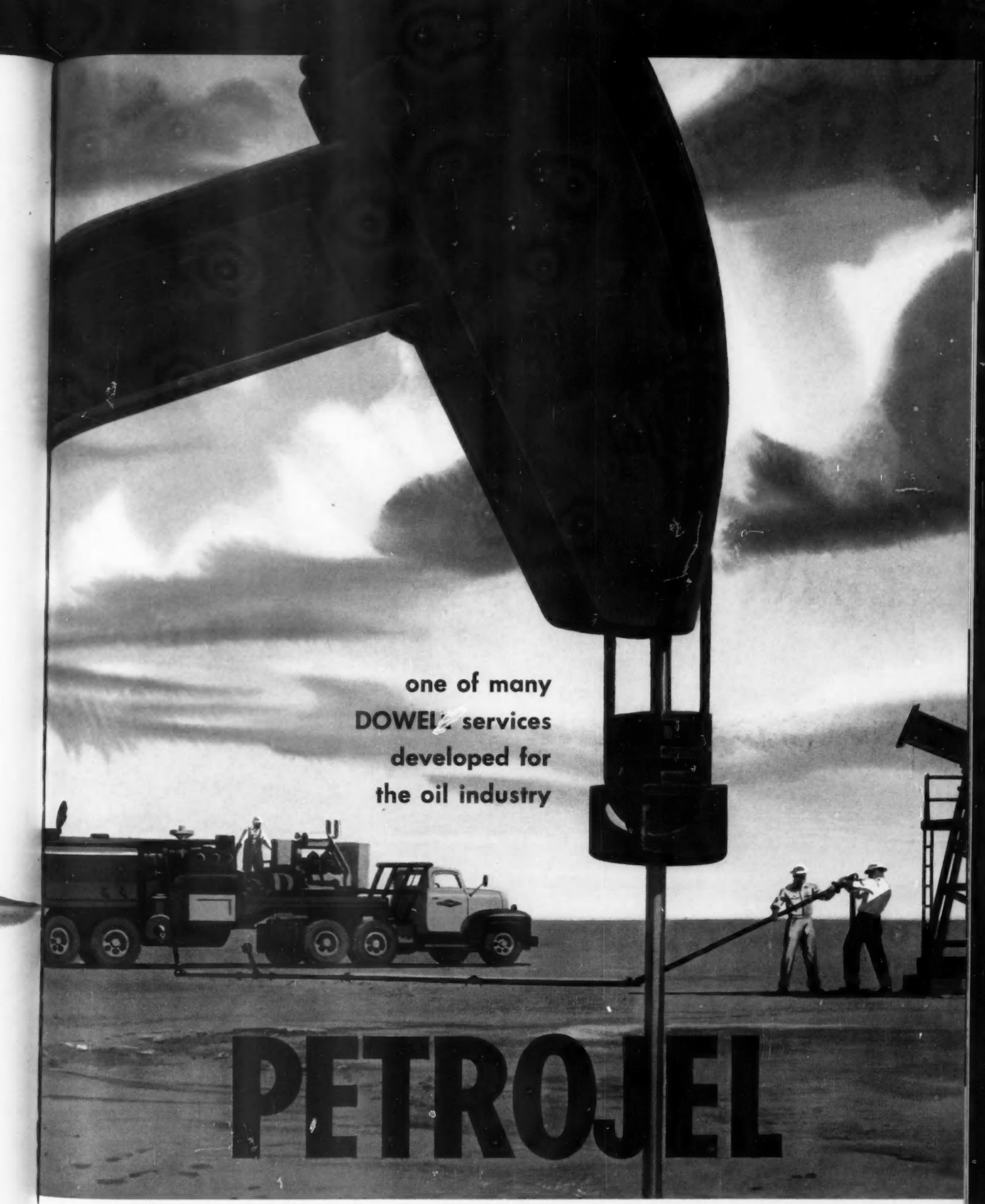


PETROJEL* by Dowell is designed to offer the benefits of a gelled lease crude—to carry sand farther into fractures with less fluid loss. Advanced research and 23 years of experience come to you fast via the modern equipment of Dowell.

**Service mark of Dowell Incorporated*

services for the oil industry

DOWELL

A Service Subsidiary of The Dow Chemical Company

DOWELL INCORPORATED • TULSA 1, OKLAHOMA

Two strings of Bethlehem X Mayari rods, activated by these Bethlehem pumping units, pump from two formations within one string of casing. Well is operated by Stanolind Oil and Gas Company.

Two Wells In One

You don't find this type of well every day—a dual well, equipped with two pumping units, pumping from two different formations, yet within the one string of 7-in. OD casing. It is Well No. 15 of the Virginia Banks Lease, and is operated near County Line, Okla., by Stanolind Oil and Gas Company.

The installation consists of two strings each of 2-in. EUE tubing and Bethlehem ¾-in. Sucker Rods, operating within one string of 7-in. OD casing. A bottom-hole pump is set in each formation. A special packer is set about midway between the two producing zones. The tubing in the lower zone is run through the packer.

The well, with its two strings totaling nearly 10,000 ft of Bethlehem ¾-in. X Mayari Sucker Rods, was put on pump in June, 1954. The larger of the pumping units, a Bethlehem 228D-20S, produces 30 bpd of 24 specific gravity oil from 5000 ft. The smaller unit, a Bethlehem 114D-14SA, produces 11 bpd of 34 specific gravity oil from 4360 ft.

The Bethlehem X Mayari Sucker Rod is one of five types of carbon and alloy rods produced by Bethlehem to help you obtain maximum pumping efficiency. If you have any question about which rod would be best for a particular pumping operation, get in touch with your Bethlehem sucker-rod distributor, or drop a line to us at Bethlehem, Pa.

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

Export Distributor:
Bethlehem Steel Export Corporation, New York

BETHLEHEM STEEL

BETHLEHEM STEEL

NOW . . . you can fill casing from bottom more efficiently than ever!

RECTOR Type "O" Fill Shoe and Fill Collar

Used in conjunction with each other, Rector Type "O" Fill Shoe and Fill Collar provide an automatic constant fill; increase operating flexibility while running casing and during cementing operations. They reduce running time, increase safety, efficiency and economy and minimize the danger of sticking pipe.

RUNNING TIME REDUCED because manual fill is eliminated.

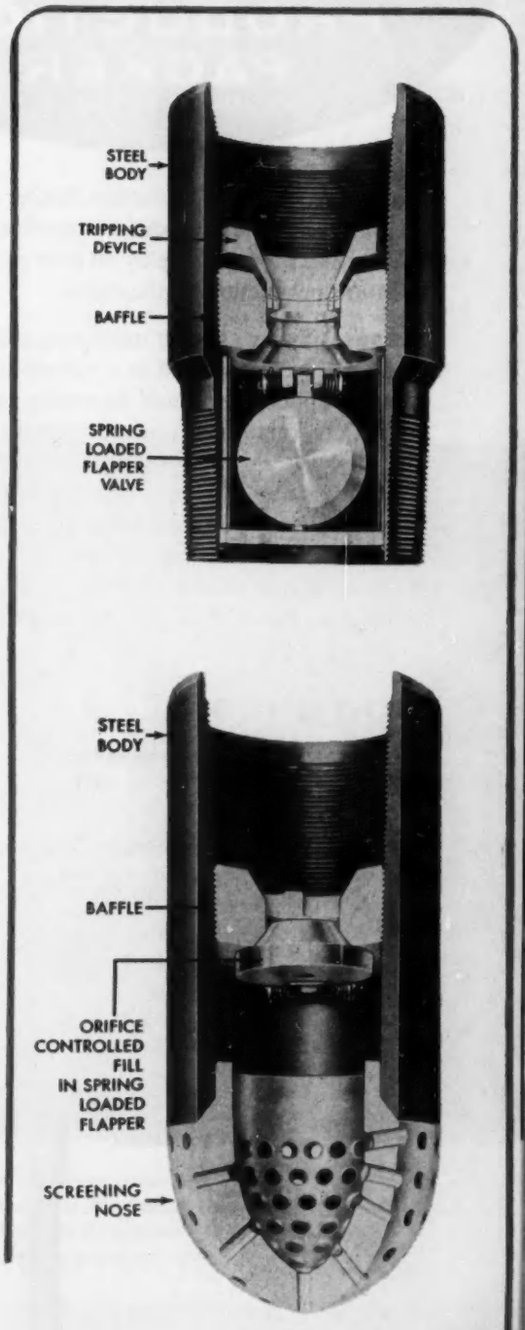
PIPE STICKING MINIMIZED because no "stops" are required to fill from top.

REDUCES PRESSURE SURGE and danger of breaking-down formations, causing lost circulation and loss of drilling fluids.

UNRESTRICTED PASSAGE OF FLUID permits greater volumes through shoe and collar at reduced pump pressures with higher velocity in annulus.

ORIFICE FILL AFTER CIRCULATION. You can stop and circulate as often and long as desired with continued orifice fill when running is resumed.

CONVERTS TO FLOAT WHEN DESIRED, by tripping flapper valve in collar which provides positive closure.



• Internal parts of both shoe and collar are a special aluminum alloy which has greater strength and abrasion resistance, plus easier and faster drill out.

The Type "O" Fill Shoe has a perforated aluminum alloy nose and baffle which is equipped with spring-loaded flapper valve with orifice choke. Orifice inserts are available in various choke diameters engineered for all pipe sizes.

The Type "O" Fill Collar has an aluminum alloy baffle, spring-loaded flapper valve and shear pin assembly for holding valve open. It functions as a back pressure valve or float collar. The flapper valve can be closed at any time by dropping a trip ball in casing at surface. At 650 p.s.i. pump pressure the ball releases flapper valve to provide a positive closure. Ball gravitates, or is pumped into nose of shoe.

If casing is run to total depth with orifice fill, ball is not used. Seating of cement plug on fill collar releases and closes flapper valve which then acts as back pressure valve, providing positive flow-back control.

25 YEARS

RECTOR WELL EQUIPMENT COMPANY INC

★ MAKING THE OIL INDUSTRY SAFER

1100 NORTH COMMERCE ST. FORT WORTH, TEXAS

Houston Plant: 2215 Commerce St.

...One

BAKER

SINGLE ZONE

PERMANENT-TYPE WELL COMPLETIONS

RETAINER PRODUCTION PACKER

PRODUCT NO. 415-D

The Baker Retainer Production Packer has been used in nearly every production application, old or new, and promises to play an even greater role in future production applications.

Because it can also be used successfully as a squeeze tool, it is used in a variety of supplemental applications (such as testing, acidizing, formation fracturing, squeeze cementing, etc.) that might be required during the completion or work-over phase of a well. That is why the Baker Retainer Production Packer has been frequently referred to as the "universal" packer, because it is truly the *one* packer that can be used *for all* production and many supplemental applications.

FEATURES

Can be run and set with the speed and accuracy of wire line, as well as on tubing or drill pipe.

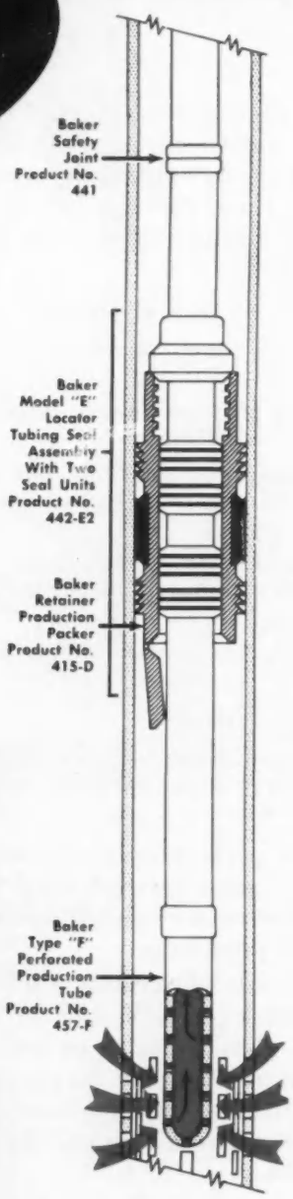
Holds any pressure from either above or below that is safe for the casing, even under temperatures in excess of 300°F.

Pack-off is independent of set-down weight or tension. Tubing string is free; just pick up (or unlatch and pick up) to remove it.

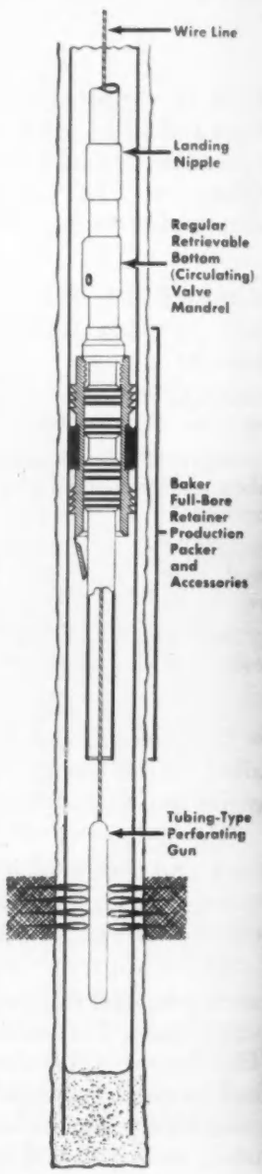
When tubing is removed, flapper valve closes to isolate zone below packer.

Baker Locator Tubing Seal Assembly Product No. 442-E2

Baker Retainer Production Packer Product No. 415-D


Baker Safety Joint Product No. 441
Baker Model "E" Locator Tubing Seal Assembly With Two Seal Units Product No. 442-E2
Baker Retainer Production Packer Product No. 415-D
Baker Type "F" Perforated Production Tube Product No. 457-F

Illustrates Packer set in casing with Locator Tubing Seal Assembly and Production Tube installed for single zone production.


Wire Line
Landing Nipple
Regular Retrievable Bottom (Circulating) Valve Mandrel
Baker Full-Bore Retainer Production Packer and Accessories
Tubing-Type Perforating Gun

Illustrates typical Permanent-Type Well Completion Hook-Up showing perforating operation through and below the Packer.

Successfully holds high pressures from above or below

. . . at shallow or record depths

even under temperatures in excess of 300°F.

Packaged Compressor Plant

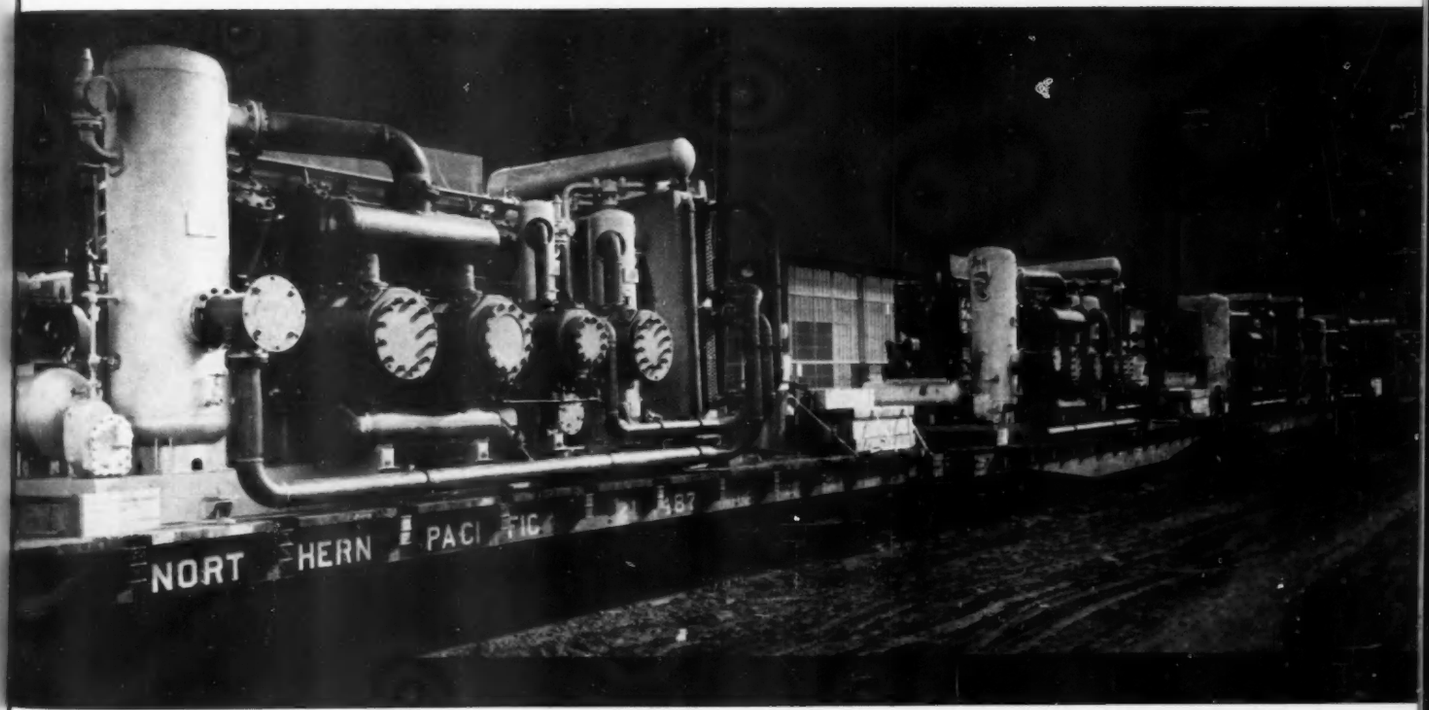
Lowest Cost Per Horsepower Installed

ARTHUR G. MCKEE AND COMPANY used this train load of Beaird-Ingersoll-Rand 8SVG packaged compressors for gas boosting service when they engineered Petroleo Mexicanos gas gathering system at Poza Rica. Located in the hot humid coastal plains of Mexico, the Poza Rica project presented many unusual operating problems: the wells to be produced were scattered over outlying, relatively unimproved areas: variations in wellhead pressures ranged from atmosphere to over 250 psig; the gas contained a high percentage of corrosive hydrogen sulfide; and leakage of air into the gas had to be avoided as it would seriously affect later processing.

Working as a team with McKee personnel, Beaird gas engineers met these critical production conditions with this group of specially designed packaged compressors. To eliminate the need for resident operators, the units were fitted with automatic controls that permit their unattended operation. Matching compression output requirements with wellhead pressures enabled all units to feed into the gathering line at equal pressures. Engine radiators, compressor fittings and scrubber elements were built from non-corrosive metals. Special gas filled stuffing boxes were designed and installed on compression cylinders, eliminating any possibility of air leakage.

Arthur G. McKee and Co. Install–

TEN PACKAGED COMPRESSORS IN PLANTS BUILT FOR PEMEX POZA RICA FIELDS



Train load of 10 Beaird-Ingersoll-Rand 8SVG 440 h.p. four cycle gas engine driven compressors enroute to Pemex Poza Rica fields. Units are equipped with Young radiators and all necessary equipment and controls. Other sizes 110 to 660 h.p.

Shipped completely assembled to location, the compressors required a minimum of time and materials for their installation. And, at a later date, they will be moved to other service as complete units, salvaging nearly all of the present installation.

Let us help you with your compression problems. Our gas engineers have years of experience in designing equipment that will handle even the most unusual conditions . . . economically. Write today.

THE J. B. BEAIRD COMPANY, INC.

Shreveport, Louisiana

BEAIRD

PACKAGED COMPRESSOR PLANTS

CAST STEEL FITTINGS

PRESSURE BULK STORAGE

ANHYDROUS AMMONIA EQUIPMENT

LP-GAS SYSTEMS

MACHINING • MANUFACTURING • STEEL WAREHOUSE

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PEOPLE throughout the United States have written to The Bank of Nova Scotia for this brochure which contains information essential to anyone interested in Western Canada's oil fields.
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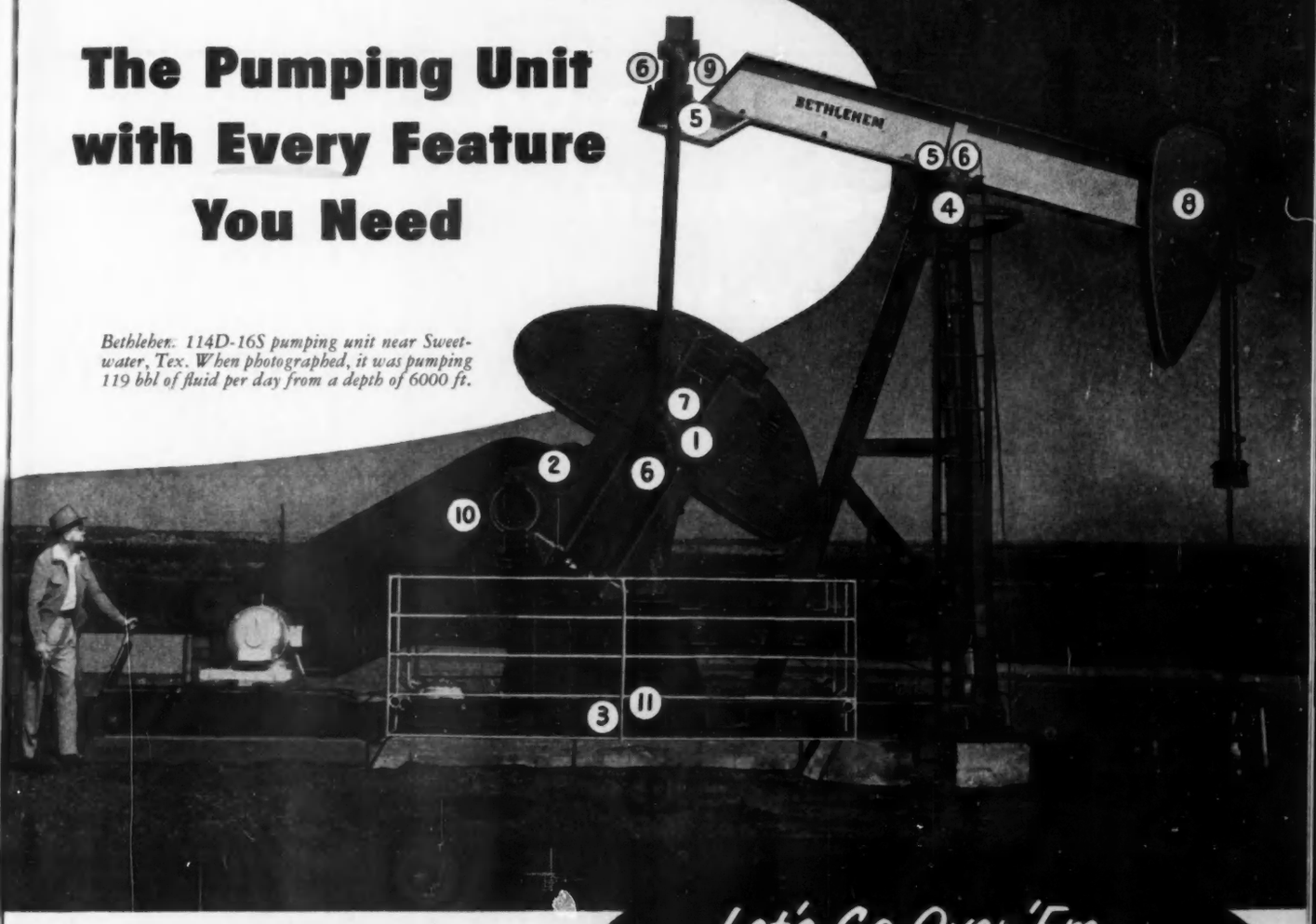
The Pumping Unit with Every Feature You Need



Bethlehem 114D-16S pumping unit near Sweetwater, Tex. When photographed, it was pumping 119 bbl of fluid per day from a depth of 6000 ft.

Let's Go Over 'Em, Point by Point:

Frankly, we don't think you could name a desirable feature that's missing from Bethlehem pumping units. To see for yourself, you're invited to study them inch by inch, down to the last bolt and nut.

It will be pretty obvious that the units are beautifully engineered—even in small details. You'll note, for example, the *very* close tolerances in the gear box. And the jig-welding of structural components for uniform, accurate fit. And the sharp-shot-peened surfaces of structural parts—a feature that makes the weather-resistant paint adhere so long and so well.

Little things, sure! But indicative of Bethlehem quality, all the way through.

For major features, see the list at the right. Can you think of any competitive unit that has them *all?*

1. **Fully adjustable rotary-type counterbalance with *safety lock*.**
2. **Full roller-bearing speed-reducer; flood lubrication of all gears and bearings in speed-reducer; forged-steel herringbone gears; rugged, strongly ribbed gear box with settling chamber.**
3. **Wide-flange reinforced base. Also available: complete range of prime-mover extension bases, and portable-base units with outrigger beams same size as main-base beams.**
4. **High Samson post for good mechanical advantage. Heavy, rugged walking beam.**
5. **Reservoir-lubricated saddle bearing and equalizer bearing; choice of centralized or ground lubrication system.**
6. **Relief valves at all pressure-lubricated points.**
7. **Keyed tapered wristpins; spherical, self-aligning wristpin bearings.**
8. **Completely removable horsehead.**
9. **Step-down equalizer, permitting equal loading in either direction of rotation.**
10. **Heavy-duty clamshell brake. Brake and pulley sides interchangeable.**
11. **Floor-clearing or non-floor-clearing models available.**

BETHLEHEM SUPPLY COMPANY

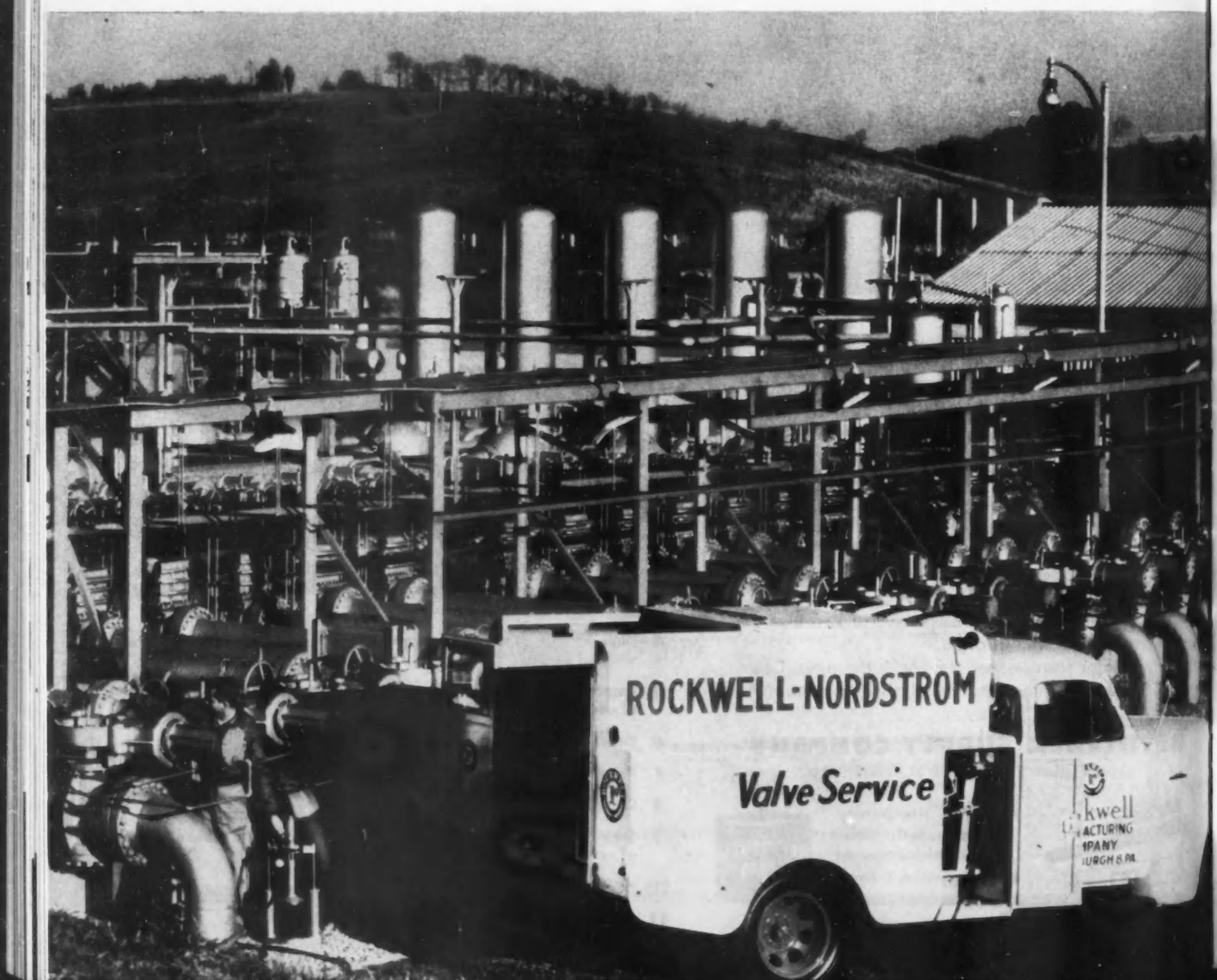
General Offices: 21 E. Second St., Tulsa, Okla.

West Coast Headquarters: Los Angeles, Calif. *Export Distributor:* Bethlehem Steel Export Corporation, 25 Broadway, New York, N. Y.

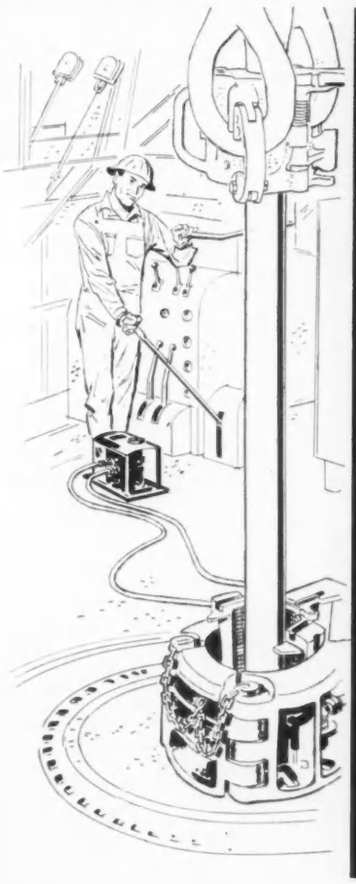
BETHLEHEM STEEL

NEW! Rockwell

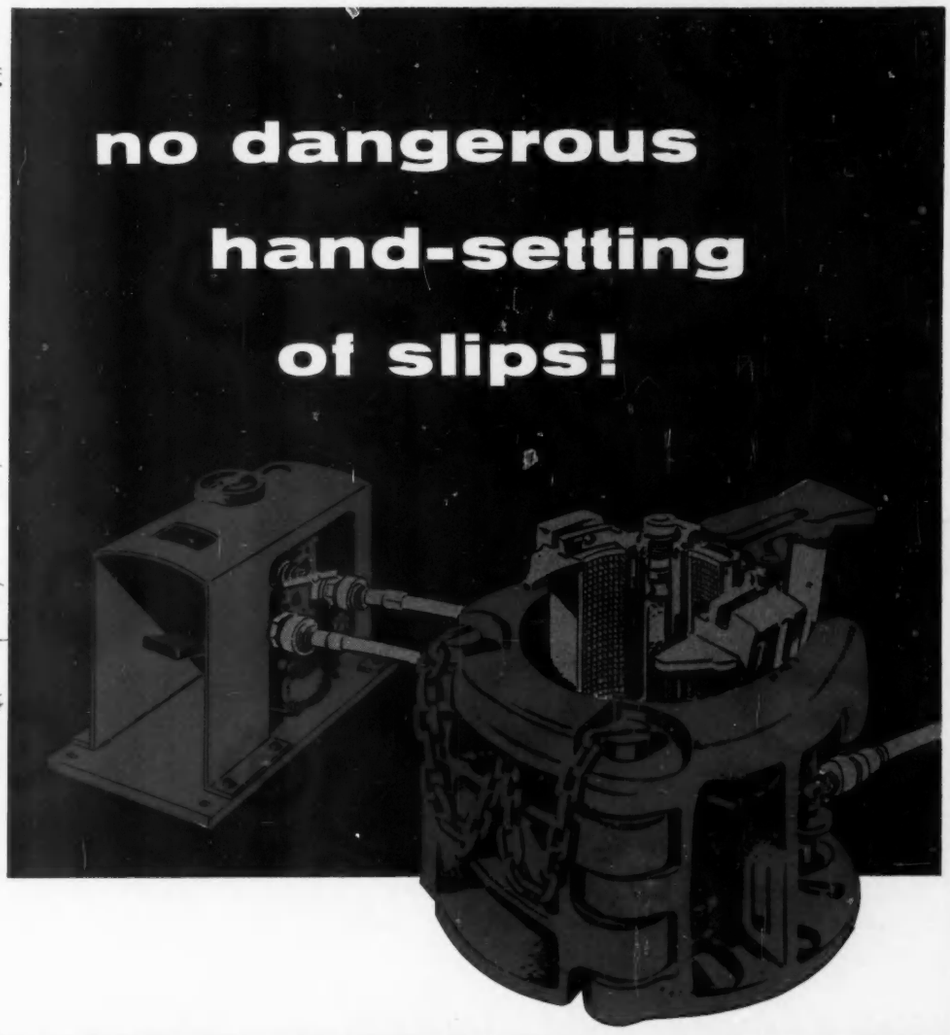
A Mobile Service
For Low Cost
Contracted Valve Maintenance



International Section



no dangerous hand-setting of slips!



BJ POWER TUBING SPIDER

Pressure-raised and pressure-set from remote foot pedal control

Completely eliminates hand-setting. Slips are pressure-raised and pressure-set by the driller or the tong man from a remote foot pedal control.

FAST... Minimizes man-effort and wasted motion ... means faster time in and out of the hole. Slips travel only a short distance. They are held in "up" position while running the stand ... have fast, positive setting action which automatically centers tubing.

VERSATILE... The BJ Power Tubing Spider can handle three sizes of tubing strings – 2⅜", 2⅞" and 3½" O.D. – with just a simple change of the unitized slip assembly. The same slips also operate efficiently on tubing strings with gas-lift valves. They work equally well with parallel strings – merely by removing fingers on right-hand and left-hand slips. Spider is readily adaptable to rotary tables for well completion, clean-out, workover and slim-hole drilling.

AVAILABLE IN TWO SIZES: Medium Weight (50-ton capacity) for depths to 10,000 feet. Working pressure – 50 psi. Heavy Weight (75-ton capacity) with extra long 9-inch slips which prevent crimping of tubing on the longest strings. Working pressure – 60 psi.

CHOICE OF POWER SOURCE... Available in air-powered or hydraulic-powered models. Can operate off the regular system of your rig ... or can be supplied with BJ auxiliary trailer-mounted air compressor or hydraulic power unit.

Power Partners to the Power Spider

The BJ air-powered Powairmatic Tong and the BJ Hydratorc Tong are natural partners to the Power Spider, using power for fast, efficient make-up and break-out of tubing and lightweight pipe.

Write for Bulletin No. BJO-679

Byron Jackson

Division of Borg-Warner Corporation

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After months of preparation, the 21st (1955-56) edition of *The Composite Catalog of Oil Field and Pipe Line Equipment* soon will be ready for mailing. It will be some time before the thousands of copies can be processed through the Post Office, but the volumes available to you and your company should be on their way in the near future.

From a survey of a cross-section of users, it was decided this year to publish *The Composite Catalog* in three volumes instead of two. Respondents to the survey voted heavily in favor of the move, in view of the size to which the two-volume edition had grown.

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The precision sectional liner of the RLA Pump (stationary barrel with top lock hold-down) provides a straight, true liner column through which the plunger operates freely. Stationary outer jackets prevent agitation of corrosive fluids along the outer surface. Top lock suspension prevents sand from settling between tubing and outer barrel.

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(Continued next page)

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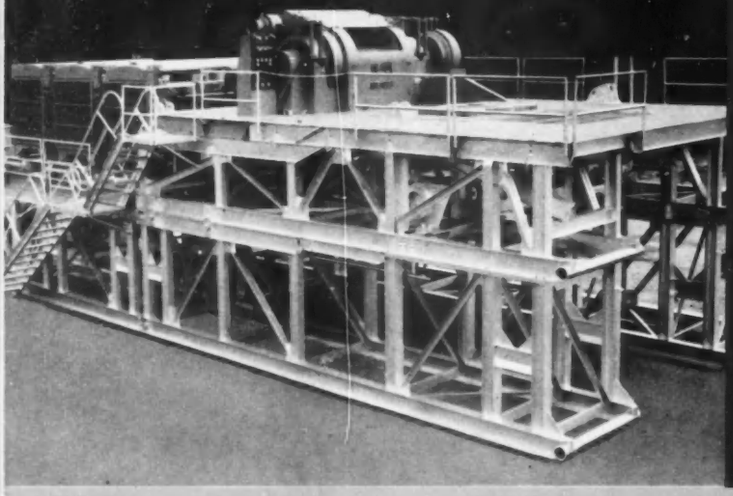

Specifications

LET'S TAKE A LOOK INSIDE OF A

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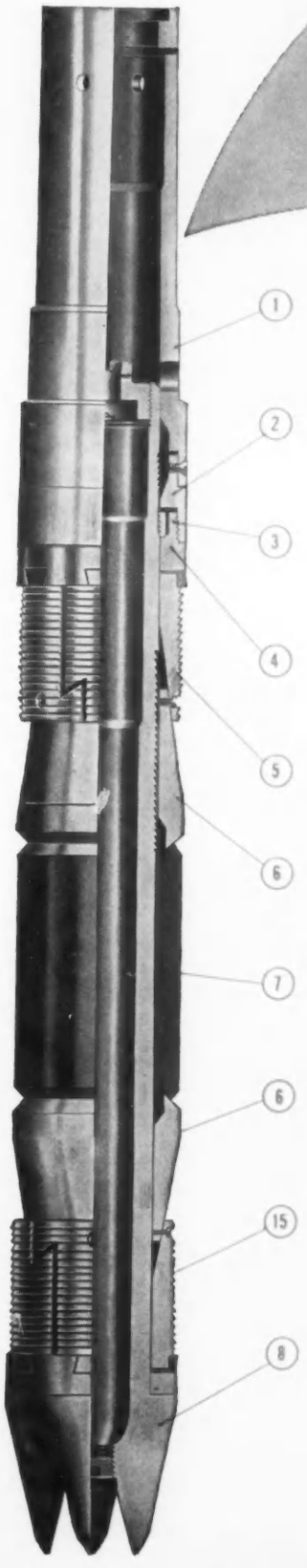

and see how and why it gives such positive packoff against pressures either up or down

1. Ram Adapter, to transmit downward pressure of setting tool. It may be removed after the plug is set.
2. Lock Ring Adapter forms a housing to enclose the lock ring and prevent its movement after engagement with the body.
3. Lock Ring, triple-wickered, engages wickers on the body to prevent any unsetting action after packoff. Both lock ring and seat are tapered so that, the greater the external pressures, the tighter the locking action.
4. Slip Locking Ring acts as a guide for the slips, which are dovetailed into it, insuring even movement and equal pressure against the casing on all sides.
5. Upper Slips support the body against pressures from below and prevent upward movement of the set plug.
6. Cone. The two cones force the slips against the casing and expand the packing sleeve for leak-proof packoff.
7. Packing Sleeve of oil-and-gas-resistant synthetic rubber is double-lipped, with a wire in each lip, to insure positive packoff and fast running without premature expansion. The greater the differential pressures, the tighter the seal.

15. Lower Slips, keyed to the body, prevent downward movement of the set plug from upper hole pressures.

8. Body. The foundation of the plug. In drilling out, the body drops to bottom after the lock ring grip is broken. The bull plug fins, tapered to guide the plug into liners or other restricted passages, prevent rotation under the bit when the entire plug is to be drilled up.

If you don't have your copy of the new, revised Lane-Wells Bridging Plug Bulletin, write for it now. It gives full details on construction, applications and drillout procedures.

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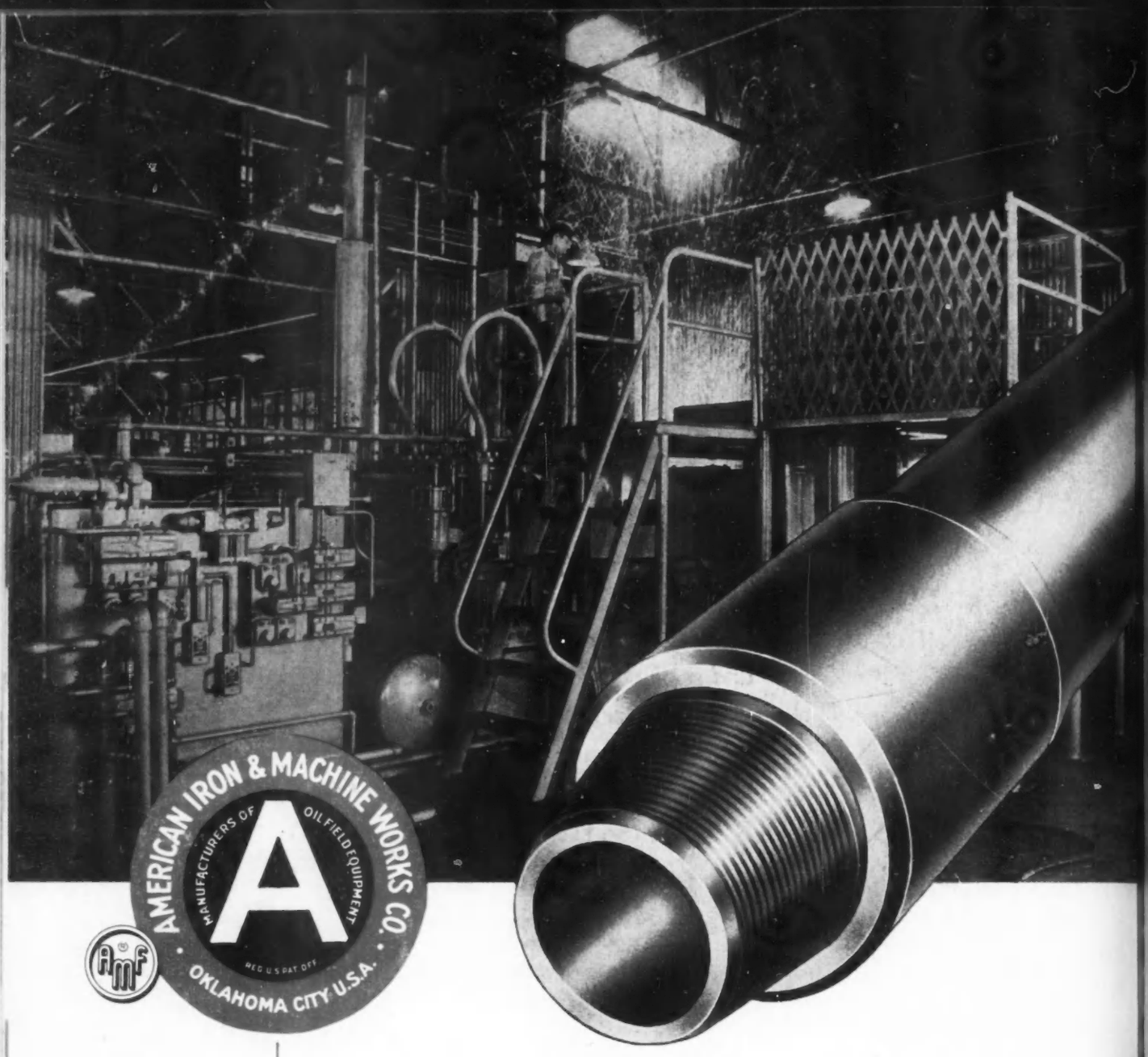

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